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AD-307 706

[redacted]

FUZE, GUIDED MISSILE, PROXIMITY, T3008E5, DESIGN and PERFORMANCE (U)

[redacted]

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TECHNICAL REPORT
• REPORT NO. TR-370 •
31 JULY 1956
COPY NO. 36

TA3-3304A

CONFIDENTIAL

DA 5A06-06-016

DIAMOND ORDNANCE FUZE LABORATORIES
ORDNANCE CORPS • • • DEPARTMENT OF THE ARMY

DIAMOND ORDNANCE FUZE LABORATORIES

John A. Ulrich, Lt Col
COMMANDING

W. S. Hinman, Jr.
TECHNICAL DIRECTOR

The Diamond Ordnance Fuze Laboratories is a Class II Ordnance installation under the Command of the Chief of Ordnance.

The mission of the Laboratories is as follows:

1. Conduct research and development in the various physical science and engineering fields directed toward meeting the military characteristics for fuzes and related items.

2. Provide consulting and liaison services as required in connection with the development, production, and use of items developed in the Laboratories or of related items.

3. Fabricate models and prototypes of items under development at the Laboratories.

4. Perform developmental testing, including destructive testing of prototypes.

5. Collect, evaluate, produce, and maintain ordnance logistical intelligence required of the Ordnance Corps under the Army Intelligence Program.

The Diamond Ordnance Fuze Laboratories was established by the Ordnance Corps, Department of the Army, on 27 September 1953. The nucleus for these Laboratories was the personnel and facilities of the Ordnance Divisions of the National Bureau of Standards. The Diamond Ordnance Fuze Laboratories is now responsible for the fuze programs formerly conducted at that Bureau.

Typical fields of activity at the Diamond Ordnance Fuze Laboratories include electronics, physics, mechanics, chemistry, and applied mathematics. Examples of topics in these activities are radiation and field studies, circuit theory and design, development and engineering of mechanical and electromechanical devices, chemical problems, and special electron tube design. The programs include all phases from basic research to product design.

ORDNANCE CORPS

DIAMOND ORDNANCE FUZE LABORATORIES

Washington 25, D. C.

ECLapham/ch/7166

In Reply
Refer to:

OCT 5 1956

ORDTL 40.0

SUBJECT: Fuze, Guided Missile, Proximity, T3008E5 for Corporal Guided Missile

TO: Chief of Ordnance
Department of the Army
Washington 25, D. C.

ATTENTION: ORDTA, Fuze Section

REFERENCE:
a. DOFL Technical Report No. TR-370
b. OCM, Items 34280 & 36069
c. DOFL ltr to OCO (ORDTA) dtd 8 Dec 1953
d. DOFL ltr to OCO (ORDTA) dtd 13 Aug 1954
e. DOFL ltr to OCO (ORDTA) dtd 24 June 1955
f. DOFL ltr to PA, Subj: Fuze for XW-31 &XW-37 Warheads on Corporal Missile (C), dtd 2 May 1956

1. Reference a. describes the design of the subject fuze, and reports the results of engineering tests and the extent of compliance with the military characteristics described in references b, c, and e.

2. The T3008E5 fuze has application as a fuze for the T25, T35, T39, T40 and other fragmentation warheads, if a fuze mounted in the "A" section (nose cone) is acceptable. This fuze is also applicable to chemical warheads where high altitude fuze function is a requirement. Reference f. proposed the application of the subject fuze to the XW-31 and XW-37 warheads under consideration for the Corporal guided missile.

3. In view of the satisfactory results of the engineering tests, it is recommended that the T3008E5 fuze be considered in planning possible utilization of the Corporal weapon system. If there is a requirement for the T3008E5 fuze, it is recommended that it be released to production engineering. If additional procurement is contemplated, the recommendations in reference a. should be considered.

If ~~enclosure No.~~ Copy 7 Ref a is withdrawn (or not attached), the classification of this correspondence will be downgraded to Confidential in accordance with paragraph 9d, AR 380-5.

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OCT 5 1956

SUBJECT: Fuze, Guided Missile, Proximity, T3008E5 for Corporal Guided Missile

4. No further development effort on the T3008E5 fuze is contemplated at this time at these Laboratories.

FOR THE COMMANDER:

W. S. Hinman Jr.

W. S. HINMAN, Jr.
Technical Director

CC:
PA, Mr. Robert M. Schwartz
AOLO, Sandia Base, Col G.W. Taylor
RSA, ORDDW-GMTW, Lt. J. Siller
CONARC, Ft. Monroe, Va., w/copy of ref a.
OAC (ORDLY-A, Spec. Weapons (J.V. Wall), w/copy of ref a. Copy 7
ORDIM, w/copy of reference a.
ORDTU, Lt. Col. M. R. Collins

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DIAMOND ORDNANCE FUZE LABORATORIES

DOFL PROJECT | **DOFL REPORT**

4103-40441

WASHINGTON 25, D.C.

TR-370

Copy No.___

31 July 1956

FUZE, GUIDED MISSILE, PROXIMITY, T3008E5

DESIGN AND PERFORMANCE (U)

R. E. Taylor

GROUP-3
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ORDNANCE CORPS • • • DEPARTMENT OF THE ARMY

FOR THE COMMANDER:

J. P. Spalding, Chief
Laboratory 40

Reviewed: R. T. Fitzgerald, Chief
Section 41.03

Approved: B. M. Horton, Chief
Branch 41

CONTENTS

ABSTRACT (U)

The design and performance of Fuze, Guided Missile, Proximity, T3008E5 for the Corporal missile are described. Based on the results of the limited test program, the extent to which the fuze meets the military characteristics is discussed.

1. INTRODUCTION

Fuze, Guided Missile, Proximity, T3008E5 has been developed for use with the Corporal XSSM-A-17 guided missile. At a very early date in the Corporal guided-missile program, it was determined that this supersonic, surface-to-surface missile must be equipped with a proximity fuze. The military characteristics for the T3008 fuze are contained in the minutes of The Ordnance Committee, Item 34280, which were approved on 5 June 1952. The fuze nomenclature was established in the OCO (ORDTA) letter to DOFL, file 00/5U0-33632, dated 2 September 1955. Department of the Army subproject 506-06-016, Ordnance Corps Project No. TA3-3304A, was established for the development of the proximity fuze for Corporal. The OCO (ORDTA) letter to DOFL, file 00/4S-4771, dated 21 June 1954, initiated the development of the "Extended Range" (T3008E5) fuze.

Data on important characteristics of the Corporal missile are given in Figures 1, 2, and 3. The "A", "B", "C" warhead-fuze sections, illustrated in Figure 2, join to the body of the missile, which consists of the guidance and control section, the fuel storage section, and the propulsion section.

The missile is launched vertically and is accelerated to a supersonic speed under the propulsion of a liquid-fueled rocket motor. It is designed to fly a series of standard trajectories similar to the one illustrated in Figure 3. Range and direction are controlled and programmed by the ground radar and Doppler equipment. The ground-based equipment also furnishes a command control for arming the proximity fuze.

Research and development of the T3008 fuze were originally undertaken in 1951 by one of the ordnance electronics divisions of the National Bureau of Standards at the request of the Ordnance Corps, Department of the Army. The staff of these divisions of the National Bureau of Standards formed the nucleus of the Diamond Ordnance Fuze Laboratories, which was established by the Department of the Army in September 1953. The Guided Missile Fuze Laboratory, one of the major segments of the Diamond Ordnance Fuze Laboratories, has continued the research and development effort on the T3008 fuze.

The design of the E5 model of Fuze T3008 was determined after laboratory and field-test evaluation of preceding models, designated E0, E1, E2, and E3, representing successive development stages of the fuze. The

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Missile:	Type	Surface to surface
	Length	45 feet
	Outside diameter	30 inches
	Velocity	Mach 3.5
	Altitude (max)	135,000 feet
	Horizontal range	85 miles
	Propulsion	Liquid fuel rocket
	Guidance	Ground-controlled programming
	Warhead	Up to 1,500 pounds

Target: Ground installations

Figure 1. Corporal, XSSM-A-17, missile.

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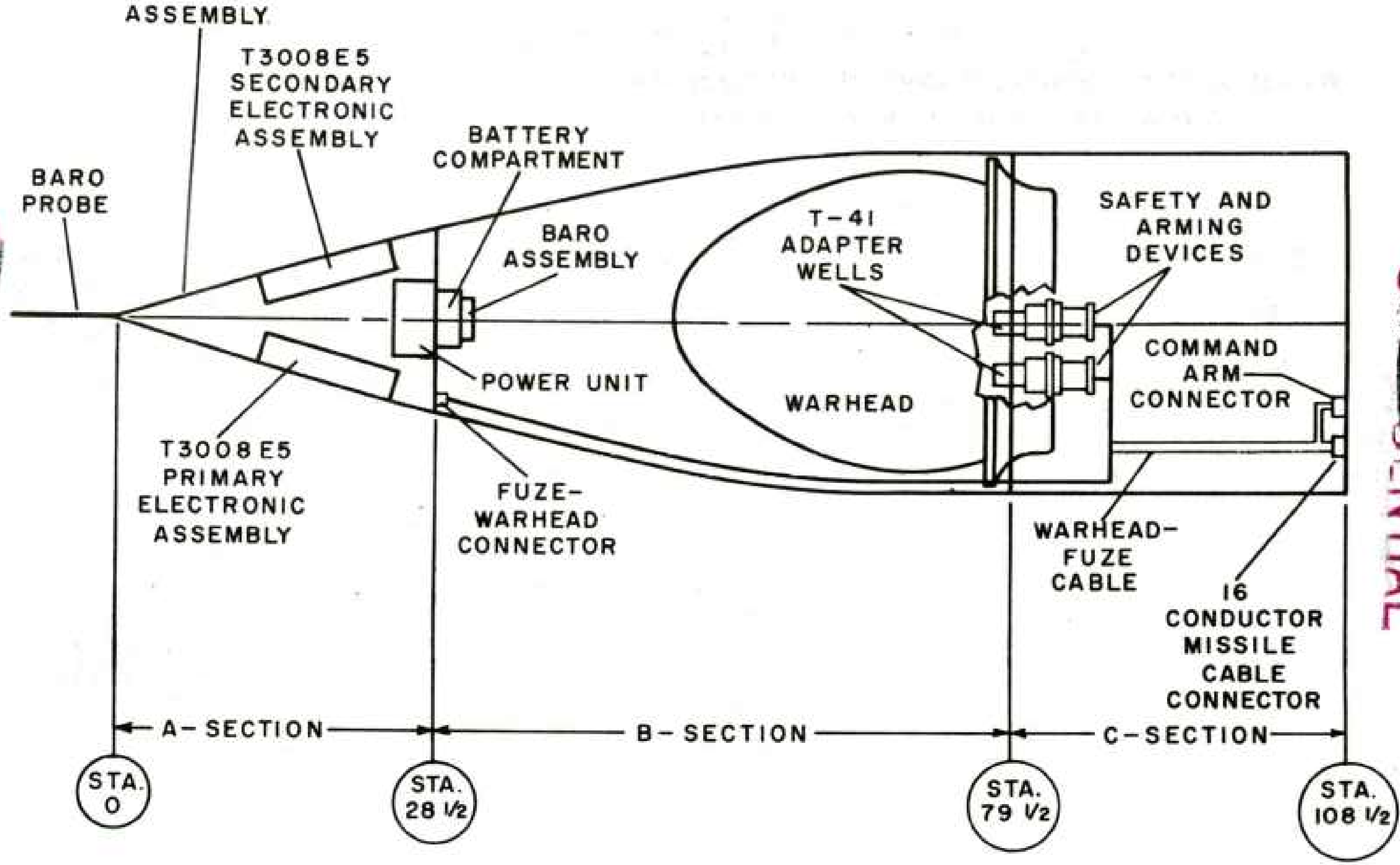

Figure 2. Outline drawing of the Corporal warhead-fuze section.

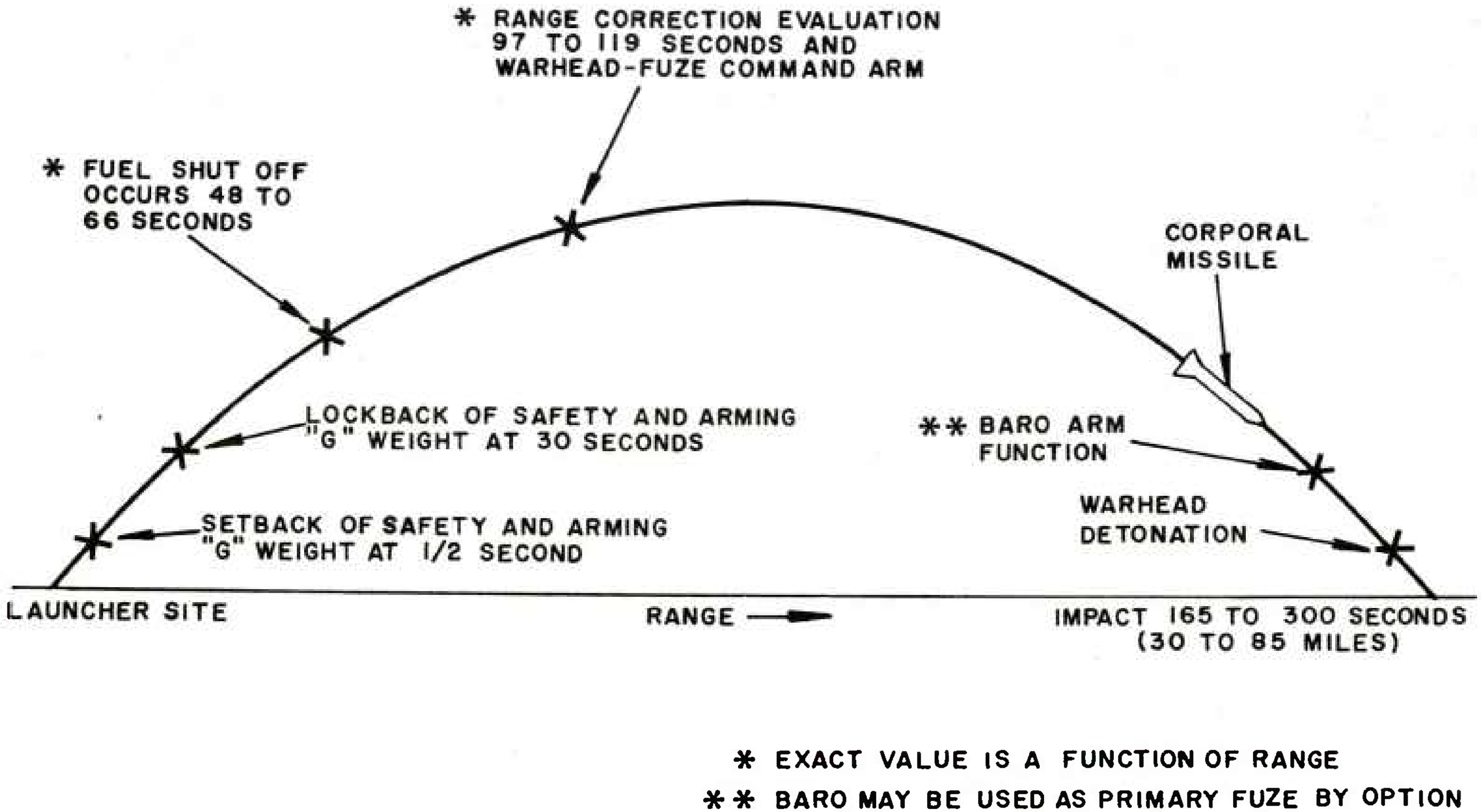

Figure 3. Sequence of T3008E5 fuze events.

design of the E5 model is detailed in this report and in the supporting reports listed in the bibliography.

Information on design and laboratory and field-test evaluation is presented in this report to provide a basis for possible future action with regard to the design release of the Fuze, Guided Missile, Proximity, T3008E5.

2. CONFORMANCE WITH MILITARY CHARACTERISTICS

The objective of the T3008E5 project has been to design a fuze for the Corporal missile in accordance with the military characteristics described in OCM 34280. The design objectives for the T3008E5 fuze were delineated in the letters to OCO (ORDTA) from DOFL, dated 13 August 1954 and 24 June 1955, respectively. The results of the tests and evaluation, which were performed as part of the development program, indicate that the fuze design objective (except for the maximum operating height of the electronic system and a temperature characteristic of the safety and arming device) has been conditionally achieved. Further testing of the fuze design should be performed in order to permit a more conclusive evaluation of its military characteristics.

The extent to which the T3008E5 fuze conforms to the design objectives and military characteristics is explained below:

a. Function Height

"The design objective shall be to develop a fuzing system to function warheads for the Corporal missile, for preset heights between 75 and 20,000 feet above the surface of the ground. Dual electronic absolute-altimeter devices, employing T3008E3 techniques, will be used for functioning heights between 75 and 5,000 feet. Barometric devices will be used for sequential turn-on operations, and for extending the fuze operating range from 5,000 to 20,000 feet."

The results of missile flight tests, and aircraft tests indicate that the dual electronic system of the T3008E5 fuze will function satisfactorily from 75 to 1,500 feet over all types of terrain. The results also indicate that the T3008E5 fuze barometric device will function satisfactorily from 5,000 feet to 20,000 feet above the target (maximum target altitude not to exceed 10,000 feet above mean sea level). The barometric device can be preset to function as low as 3,500 feet above mean sea level.

"An additional design objective (see DOFL letter to ORDTA, dated 8 December 1953, MJBlock/th/7404) has been to develop a T3008 fuze for the Corporal missile, which will function in excess of 99 percent of the cases where the fuzes are armed by the missile radar and Doppler signals. Also, the T3008 fuze system should have an accuracy, assuming Gaussian distribution, such that sigma is 5 percent of the preset functioning height on missiles which are roll-stabilized over level terrain."

Additional tests will be required to obtain a statistically significant measure of the burst-height accuracy and operational reliability of the fuze.

b. "Be insensitive to all influences of the missile motive means or control signals that are not required for proper function."

No adverse effects of missile motive means or control signals have been observed in any flight tests. The fuze is therefore deemed to be insensitive to extraneous influences of missile motive means or control signals.

c. "Be usable under day or night conditions."

The basic fuze design, consisting of radio-frequency and barometric devices, makes it usable under day or night conditions.

d. "Be entirely capable of satisfactory performance at any air temperature from -65F, etc."

The electronic, barometric, and power-unit assemblies have been designed for operation at any ambient temperature from -65F to +165F and for storage at temperatures from -80F to +165F. To meet the low-temperature requirement, the battery compartment is provided with heaters which are to be used for a period of approximately one hour prior to launching under low ambient-temperatures. The E5 fuze has been subjected to only very limited temperature tests; but, from the results of these tests and those of the E3 and E2 designs (electronic design basically the same as the E5 design) over the prescribed temperature range, it is concluded that the electronic, barometric, and power-unit assemblies should meet the prescribed temperature requirements for operation and storage.

The safety and arming device has been designed to perform reliably its safety function under the prescribed temperature conditions. However, because of the explosive motors employed in the device, satisfactory arming action is limited to operating temperatures in the range from -25F to +130F. Explosive motors which will operate over the prescribed temperature range are considered to be feasible, and therefore this deficiency can be corrected.

In view of the present deficiency in the S and A device, the operating temperatures of the E5 fuze are restricted to the range from -25F to +130F.

e. "Design all exposed parts for minimum drag and reduce such exposed parts to a minimum."

The exposed parts of the "A" section (nose cone) have been designed to give minimum drag and to have the minimum size compatible with operational requirements. The external package design has been approved by the missile design agency, the Jet Propulsion Laboratory.

f. "Incorporate visible indication of the unarmed condition prior to assembly to the warhead. No indication of arming is thereafter required."

The S and A device has a visual indication of the arming condition which can be observed prior to its assembly in the warhead.

g. "Contain an out-of-line detonator and be safe under normal conditions of handling, shipment, and launching."

The S and A device provides an out-of-line and electrically disconnected detonator in the unarmed condition. The device has passed the Phase I safety reliability tests prescribed by Picatinny Arsenal. In no case has the handling and shipping involved in the field tests of the device resulted in its arming under circumstances which reflect adversely on its safety reliability.

It is therefore concluded that the S and A device can be expected to meet the requirement for safety.

h. "Be designed to arm only in response to the simultaneous attainment of chosen conditions, at least one of which is a direct function of the missile guidance control."

The energy to start the arming cycle is controlled by missile acceleration of a prescribed minimum value for a prescribed time duration, and the release to rotate the warhead detonator to the in-line position is controlled by command from the ground guidance station. The barometric device then provides fuze thyratron arming and microwave radiation turn-on approximately 3,000 feet above the preset height when using the electronics option.

The design of the S and A device is considered to meet fully the requirements for arming in response to the simultaneous attainment of chosen conditions.

i. "Be as immune to possible enemy jamming, or other electronic interference from other missiles in flight or other missile bursts as is commensurate with design and development factors."

Susceptibility to electronic countermeasures has been minimized by the selection of an operating frequency in the X-band, a narrow-beam antenna pattern, a balanced discriminator, an amplifier of wide dynamic range, and the incorporation of a barometric device to provide late arming. No tests have been conducted against countermeasures based on dispensing of false targets, such as chaff, but it is not expected that chaff will initiate detonation unless the distribution of the chaff is so dense that it presents a definite boundary layer.

j. "Be operable under all weather conditions including rain, snow, and clouds."

The rain and cloud conditions encountered in aircraft, and missile-flight tests are not believed to be the source of any fuze malfunctions which have been observed. The fuze has not been observed to fire in tests against simulated rain. No data is available on the performance of the fuze in snow storms.

More extensive tests would be required to determine the performance of the fuze under the most severe weather conditions likely to be encountered.

k. "Proper operation shall be unaffected by passage in flight through altitudes up to 131,000 feet."

Pressure seals are provided to maintain the pressure within the fuze during flight at substantially the atmospheric pressure existing at the launching site. This design feature provides assurance that operation of the fuze will not be affected by ambient atmospheric pressures at altitudes up to 131,000 feet.

l. "Be operable at missile velocities of 1,000 to 3,000 feet/sec."

The operation of the fuze system is essentially independent of missile velocity within the stated velocity range.

m. "Have an active life of at least 225 seconds."

The active life of the fuze is longer than 225 seconds if batteries are fully charged at turn-on.

n. "Have a storage life of at least 5 years."

The fuze design and all components were chosen to assure a long storage capability. If the fuze is stored with a desiccant in a sealed shipping container, operation of the fuze should not be impaired by storage for a period of five years. The battery electrolyte should be shipped separately in a sealed air-tight container. The nickel-cadmium battery cells should be filled with electrolyte just prior to use. Confirmatory tests of the storage life of the fuze have not been conducted.

o. "Be able to withstand maximum axial and lateral acceleration of 4g and 2.5g, respectively."

Vibration accelerations of up to 5g, which have been applied for an extended period, do not produce a measurable impairment of fuze performance. There is no evidence that the functional capabilities of the fuze are impaired by the maximum axial and lateral accelerations encountered on the Corporal missile.

p. "Be operable under conditions of loss of roll stabilization in the missile. Under rolling conditions, fuze operability may be attained at the sacrifice of fuzing accuracy."

The radiated beam of one electronic assembly of the dual fuze is directed along the longitudinal axis of the missile; this allows the fuze to operate under rolling conditions with some reduction in accuracy and reliability.

3. TECHNICAL DESCRIPTION

3.1 Theory of Operation of Electronic System

The T3008E5 fuze electronic system operates through the medium of an f-m microwave (X-band) signal. This signal is generated by a klystron oscillator which is frequency modulated by a 20-kilocycle-per-second sinusoidal voltage. The output of the frequency-modulated klystron is connected to a transmitting antenna which radiates the signal in a beam of desired shape and directivity. When the radiation is directed toward the ground, a signal is reflected from the ground and picked up on a receiving antenna which is similar to and has the same directivity as the transmitting antenna. The reflected signal picked up by the receiving antenna and a small portion of the signal from the transmitter are coupled into a balanced mixer. The instantaneous frequency of the reflected signal differs from that of the transmitted signal because of the transit-time delay of the signal from the fuze to the target and return. The output of the balanced mixer is a voltage which varies in frequency at a rate equal to the difference between the frequencies of the two inputs. This difference frequency (Figure 4) varies with altitude. The output of the mixer is amplified and coupled to a discriminator which produces a voltage output whose amplitude and polarity vary with input frequency. The output of the discriminator is coupled to the firing circuit. By proper choice of the design parameters, the fuze is made to provide a firing signal at any predetermined height above ground, provided the reflected signal level is greater than the minimum detectable signal level.

The instantaneous difference-frequency signal is a complex wave composed of many harmonic frequencies. The amplitude of the harmonic components is shown by a spectrum analysis of the complex wave. Figure 5 shows oscillograms of mixer output and simultaneous spectrum analysis of this output for reflected signals corresponding to a number of different delay times. The spectral lines, or the maximum amplitudes of the various frequency components, are multiples of the modulation frequency (20 kc).

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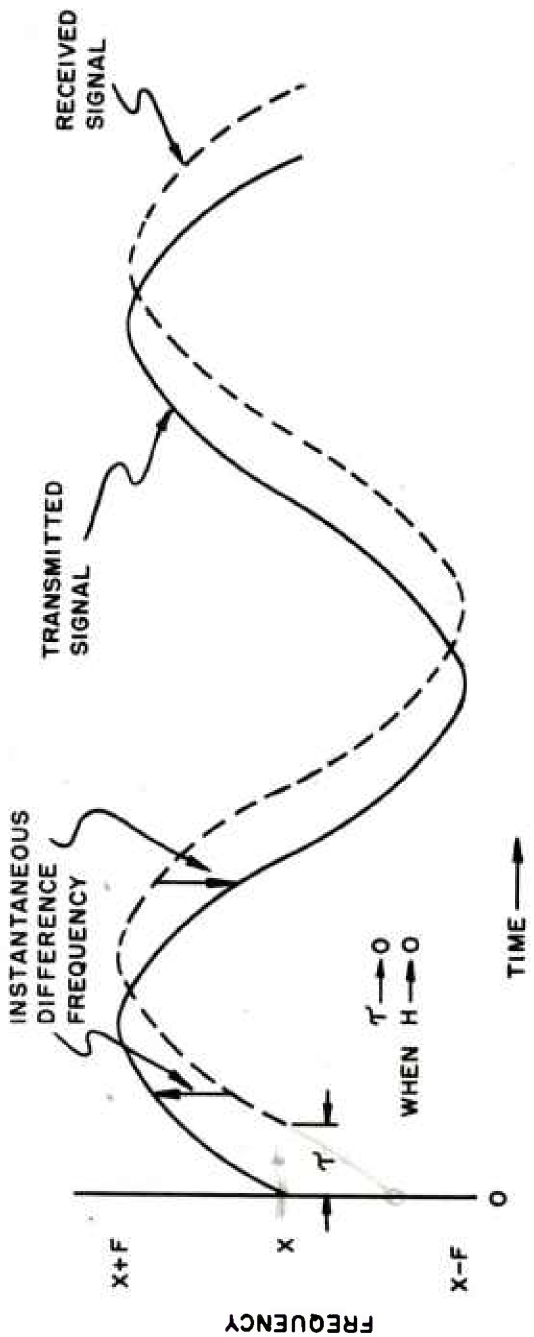

Figure 4. T3008E5 frequency vs time plot.

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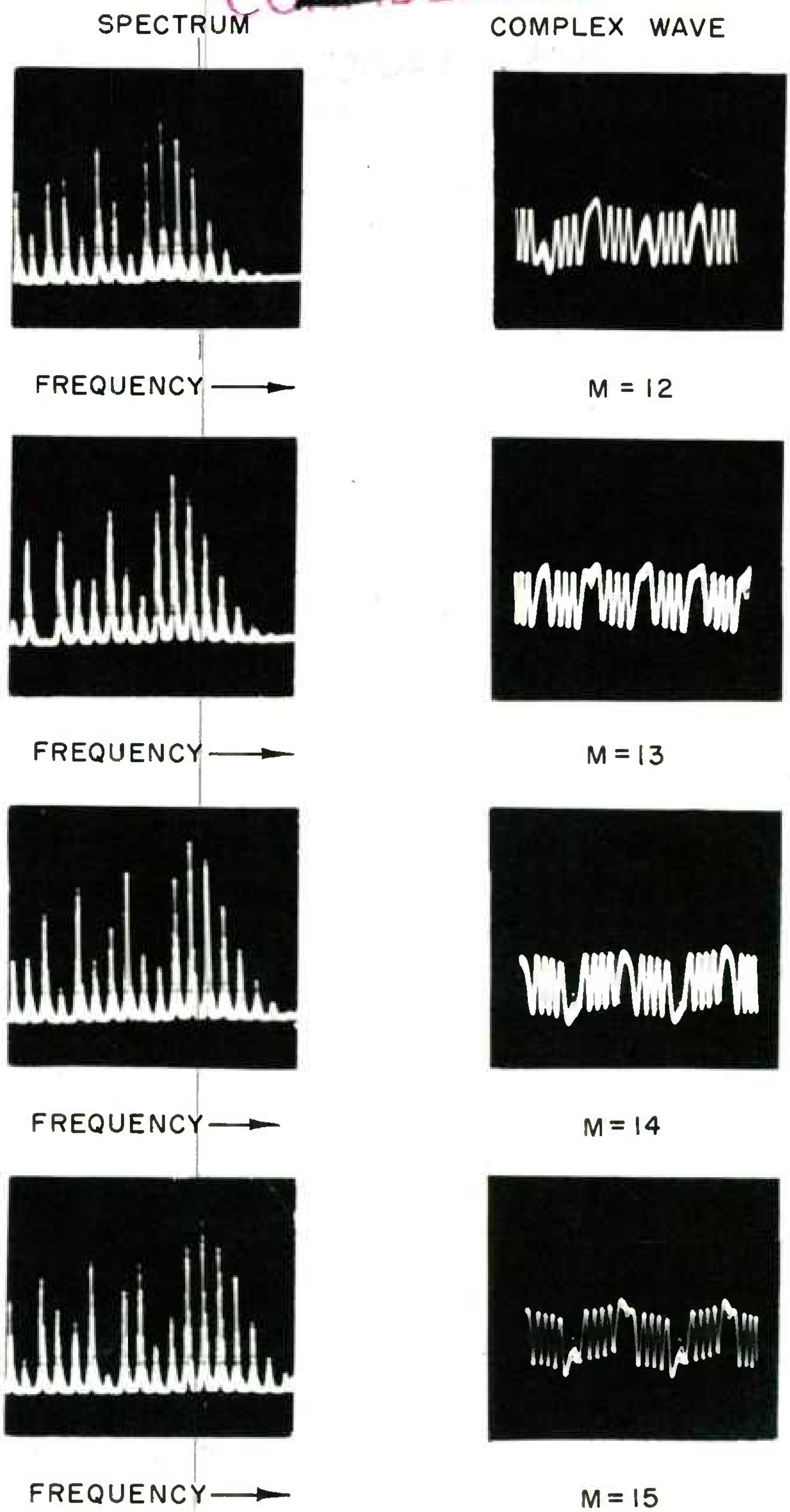

Figure 5. T3008E5 microwave mixer output signal (spectrum and complex wave).

A Doppler shift, due to the relative velocity between the fuze and the target, results in an approximately 3-db loss of spectral signal.

The spectral distribution of the complex difference-frequency signal (in the absence of Doppler) varies for different heights according to the modulation index, M. The factor M is defined by the following relationship*:

$$M = \frac{2F}{f} \sin \left(\frac{2\pi f D}{c}\right) \approx \frac{4\pi F D}{c} \quad \text{for the heights under consideration}$$

where,

F = average-to-peak frequency deviation of the transmitted signal in cycles per second

D = distance to the ground

c = velocity of propagation of electromagnetic waves in free space

f = modulation frequency (fixed).

The modulation index, M, for a given frequency deviation, F, is proportional to the distance, D. The firing signal occurs when a specific value of modulation index, determined by choice of circuit parameters, is obtained. The distance, D, corresponding to the modulation index which produces the firing signal, can be preset by proper selection of frequency deviation, F.

3.2 Physical Arrangement

The T3008E5 fuze contains two independent electronic assemblies each of which is designed to operate according to the principles described in paragraph 3.1. In addition, a barometric device has been included to provide late arming and radiation turn-on. An option circuit also permits use of the barometric device as an independent fuzing system at function heights between 3,500 and 30,000 feet (above mean sea level).

The fuze consists of three major assemblies:

(1) Nose-cone assembly
(2) Safety and Arming System
(3) Warhead-fuze cabling

The location of these major assemblies, relative to the position of the warhead, is shown in Figure 2. A telemeter package, used only during the research and developmental phase of the project, is mounted in the "C" section of the Corporal missile.

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* See Reference 5 in Bibliography.

3.2.1 Nose-Cone Assembly

The nose-cone assembly, shown in Figure 6, consists of the following:

(1) Missile nose-cone or "A" section
(2) Primary and secondary electronic assemblies
(3) Primary and secondary antenna assemblies
(4) Barometric assembly
(5) Power-unit assembly
(6) Battery compartment.

An interior view and photograph of the T3008E5 nose-cone assembly are shown in Figures 7 and 8, respectively. The weight of the nose-cone assembly, approximately 100 pounds, is distributed as follows:

"A" section cone	20 pounds
Electronic assemblies	16 pounds
Antenna assemblies	5 pounds
Barometric assembly	6 pounds
Power unit	35 pounds
Battery compartment	18 pounds
Total weight of nose-cone assembly	100 pounds

3.2.1.1 Missile Nose-Cone or "A" Section

The outline drawing of the nose cone (Figure 9) illustrates the configuration of the "A" section structure.

The nose section, which is conical in shape, has a base diameter of approximately 16 inches and a length of approximately 28 inches.

The electronic assemblies are fastened directly to the antenna housings, which are mounted on the inner surface of the "A" section. In order to reduce vibration effects, the heavier components, such as the power section and the battery compartment, are mounted on the base plate of the nose-cone assembly.

In order to prevent arc-over of the power-supply voltages during flight, the entire nose-cone assembly is pressure-sealed at the ground-level atmospheric pressure.

The electronic function-height control is accessible through a pressure plug located between the transmitter and receiver antenna elements (Figure 9).

For accessibility and easy handling, the nose-cone assembly is hinged to the "B" section of the Corporal missile by means

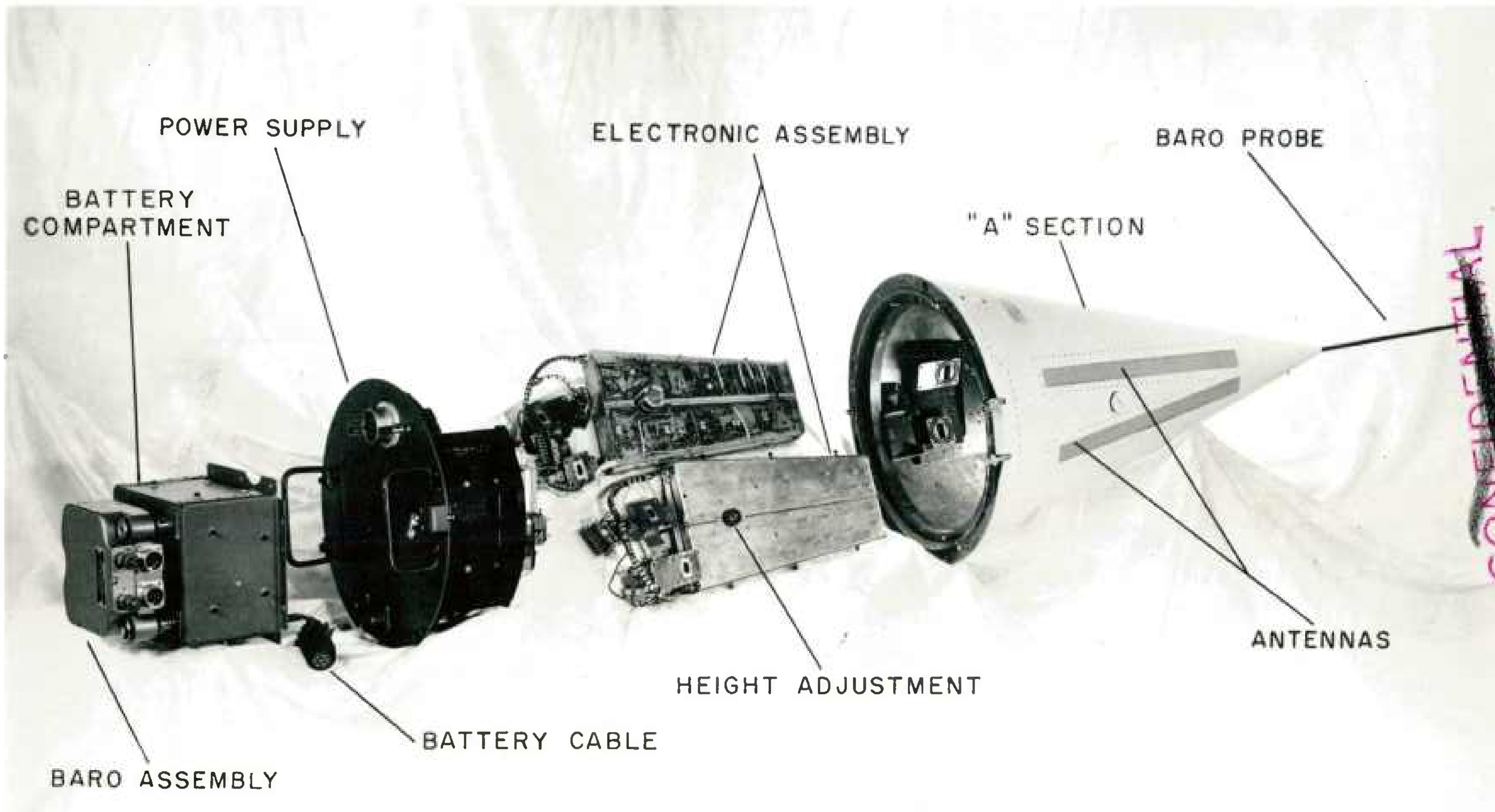

Figure 6. T3008E5 nose-cone components.

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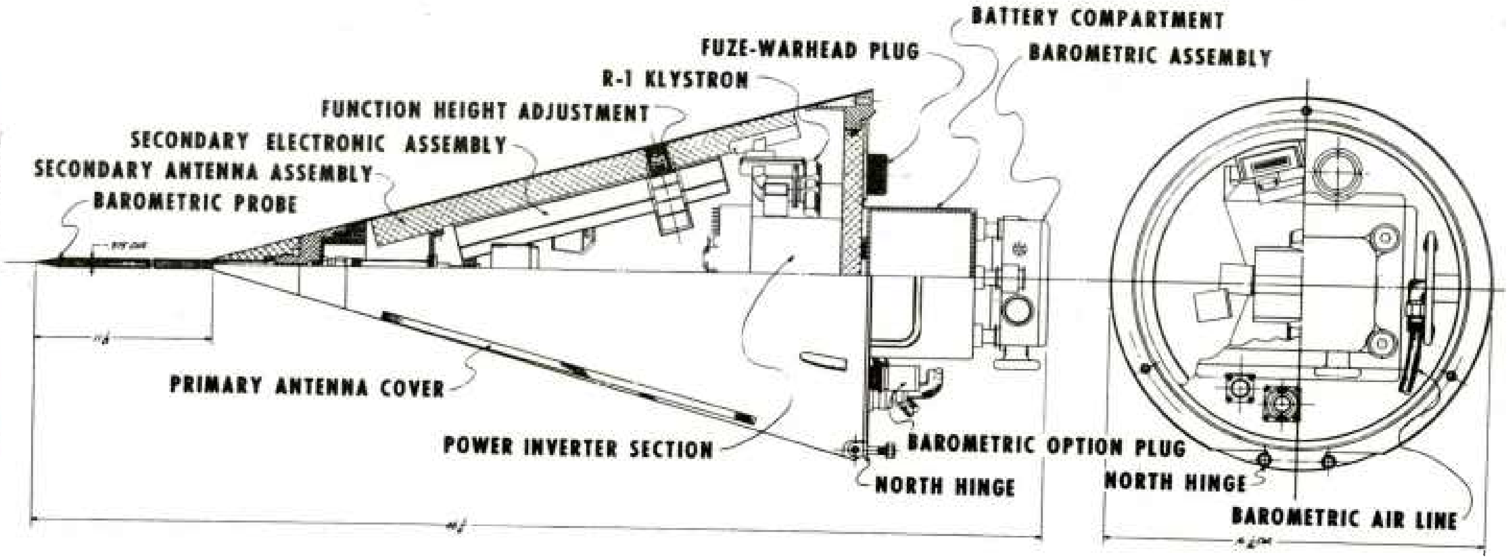

Figure 7. Assembled T3008E5 nose-cone assembly.

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of two eyebolts (Figure 10). Three captive bolts fasten the entire assembly to the "B" section.

3.2.1.2 Primary and Secondary Electronic Assemblies

The two identical and independent electronic assemblies (primary and secondary) are attached to the respective antenna housings (Figure 11). To provide thermal insulation, an 1/8-inch-thick mica-type phenolic sheet separates the electronic assembly and antenna housing.

Each electronic assembly weighs approximately 8 pounds and consists of an electronic package, a waveguide-mixer-klystron assembly and cabling with connector (Figure 12).

The electronic unit contains a servo oscillator and power supply (SOP) panel, an amplifier discriminator and firing (ADF) panel, and a potentiometer for setting the altitude at which firing is desired (Figure 13 and paragraph 3.3.1.1).

All electrical parts of the electronic assembly are mounted rigidly on an epoxy-resin-impregnated fiber-glass sheet in order to minimize vibration effects (Figure 13).

3.2.1.3 Primary and Secondary Antenna Assemblies

The primary and secondary antenna assemblies each consist of a pair of slotted waveguide elements (Figure 14). One element in each pair is used for transmitting and the other element for receiving. The antenna assemblies are mounted on diametrically opposite sides of the inner surface of the nose cone (Figures 11 and 15). The radiating surface of each element is covered with a pressure-sealed dielectric material to provide a flush strip on the outer surface of the nose cone.

3.2.1.4 Barometric Assembly, Power-Unit Assembly, and Battery Compartment

The barometric assembly, power-unit assembly, and battery compartment form an integral assembly (Figures 16 and 17) that is mounted at the after end of the nose-cone assembly.

The barometric assembly is mounted directly on the after end of the battery compartment by means of three bolts which shock-mount the assembly to minimize effects of vibration. The barometric assembly (Figure 18) has a single-knob control to adjust its function height, and a counter-indicator that indicates barometric setting in feet above mean sea level. The barometric assembly is essentially an altitude switch consisting of 4 pressure-sensing elements contained within a pressure-tight housing together with associated gearing, electrical

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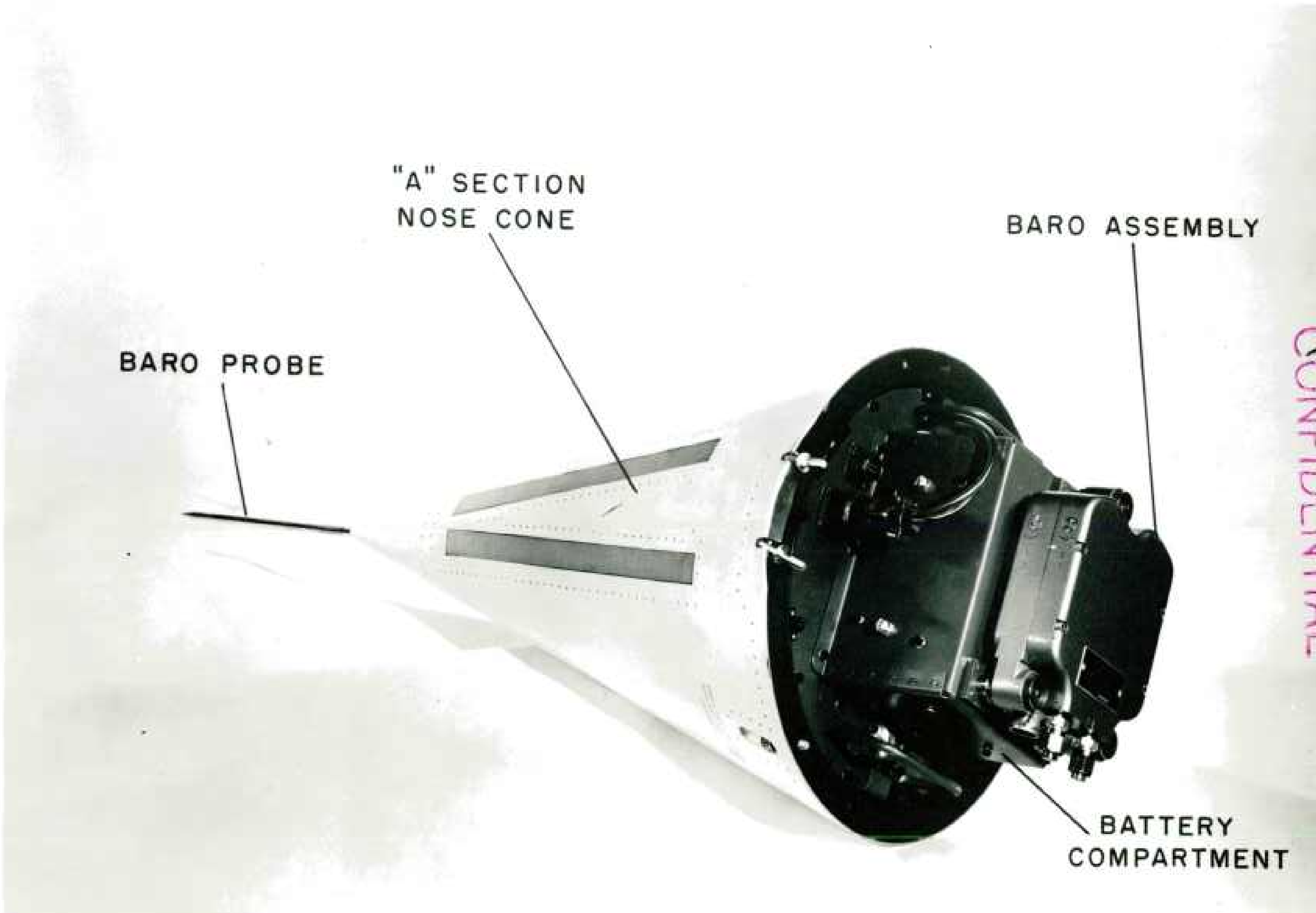

Figure 8. T3008E5 nose-cone assembly.

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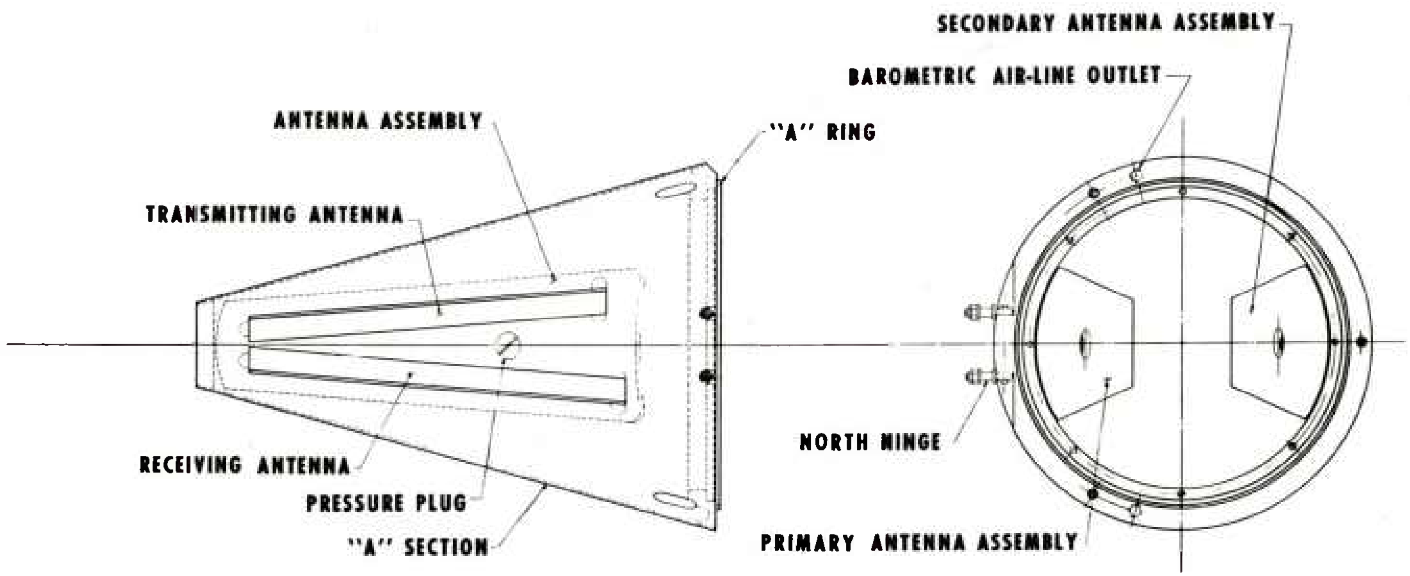

Figure 9. "A" Section nose-cone.

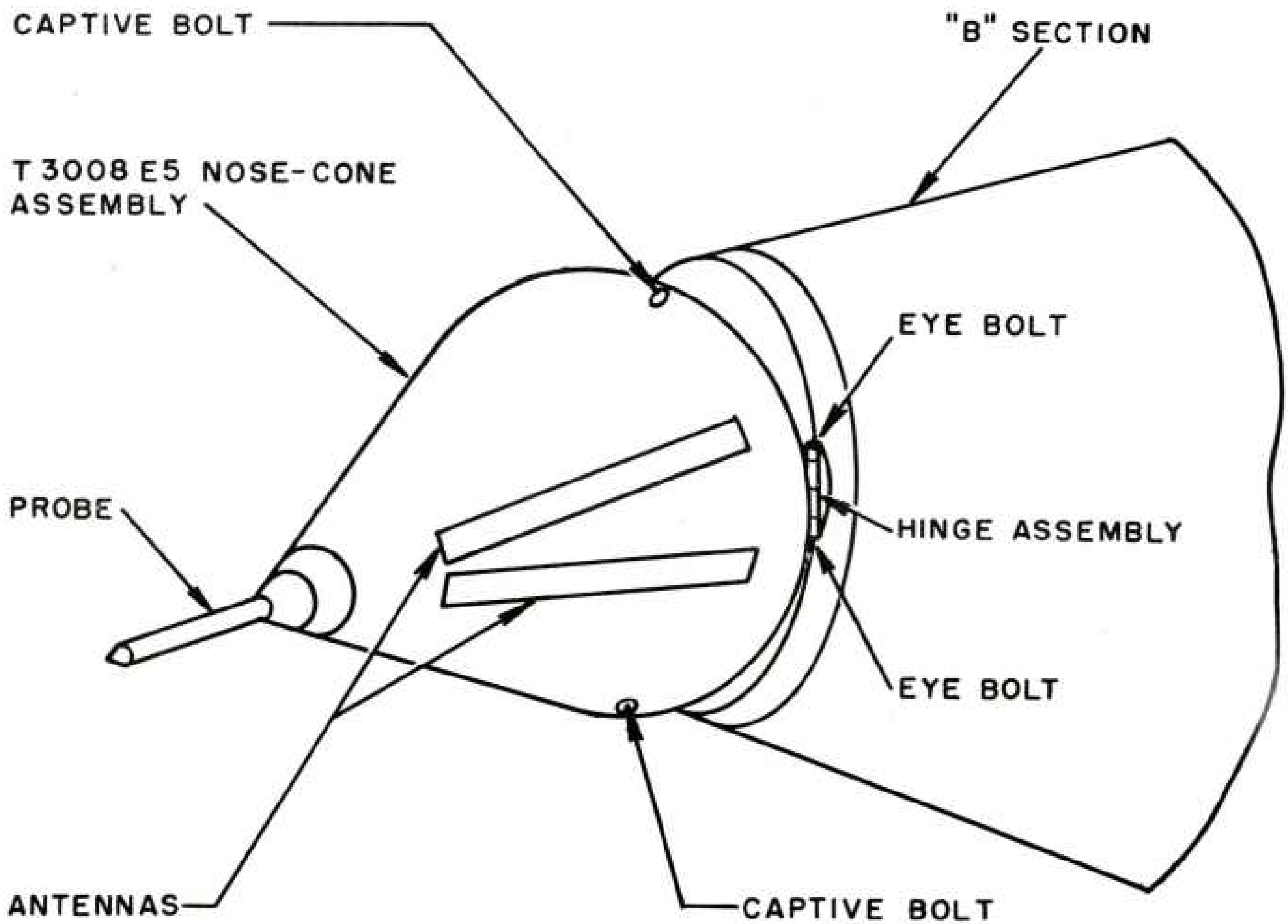

Figure 10. Method of attaching the T3008E5 nose-cone assembly to "B" section.

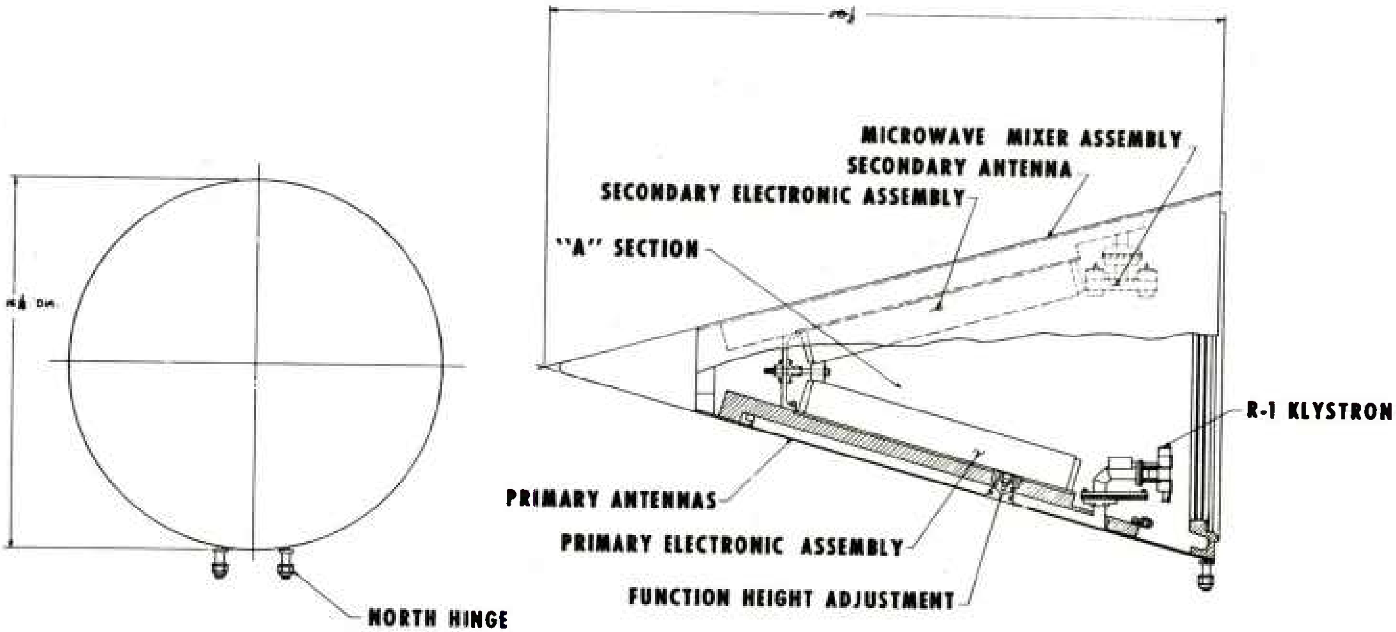

Figure 11. Nose-cone showing mounted electronic assemblies.

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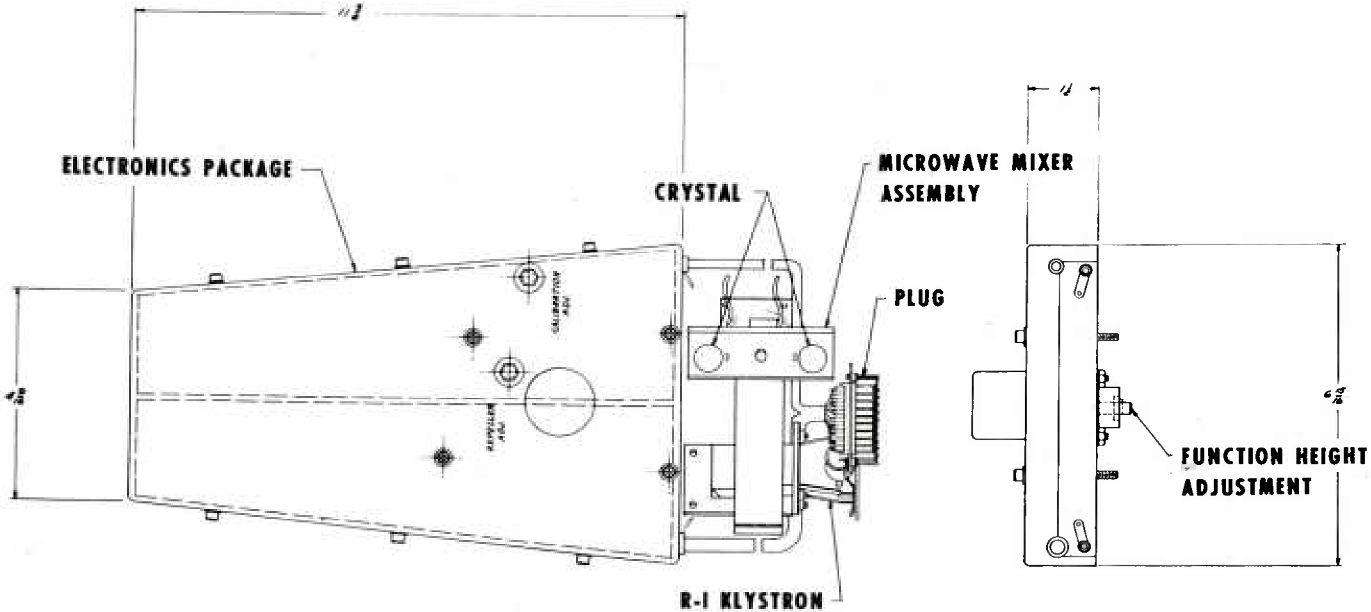

Figure 12. T3008E5 Electronic assembly.

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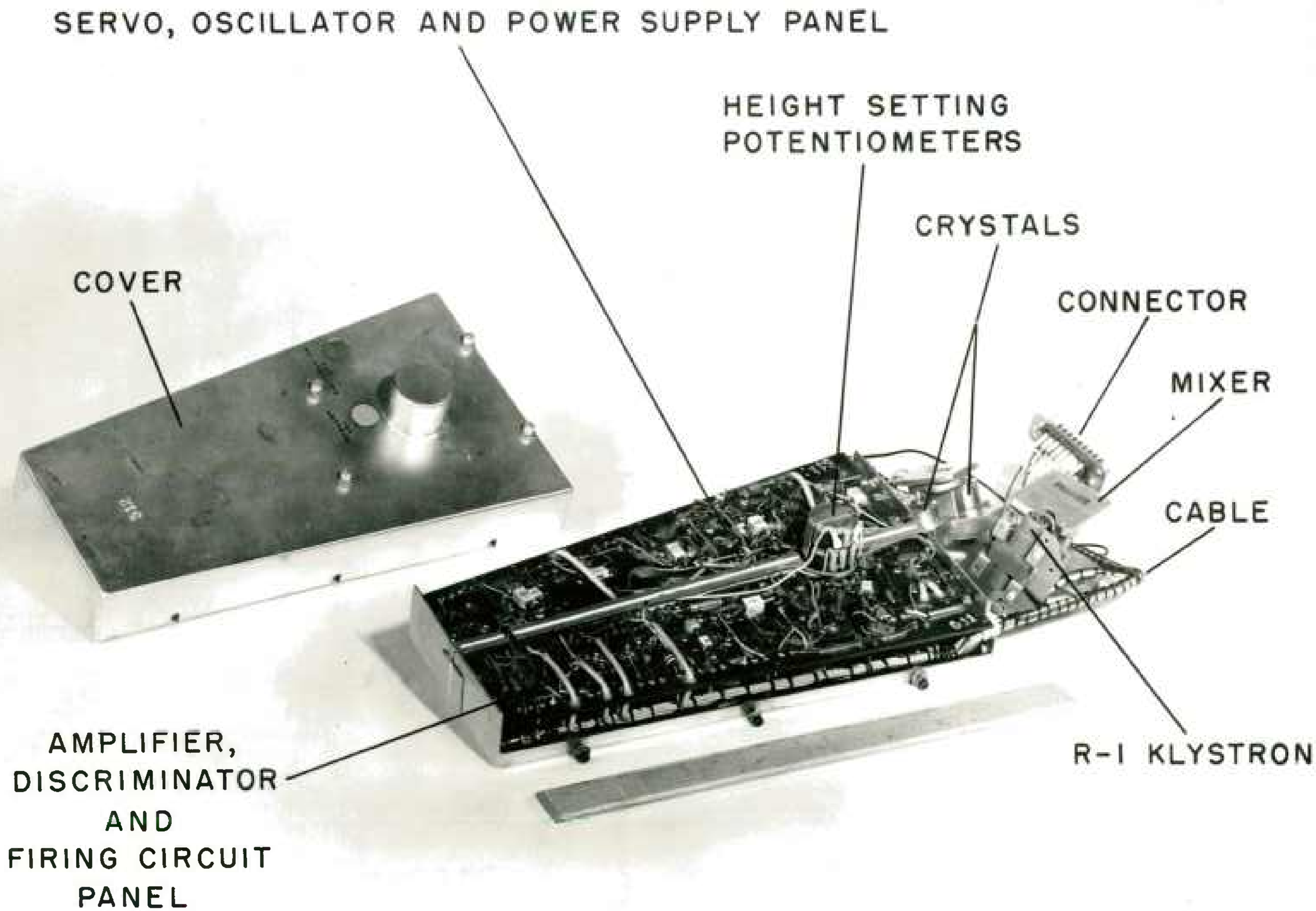

Figure 13. T3008E5 electronic assembly.

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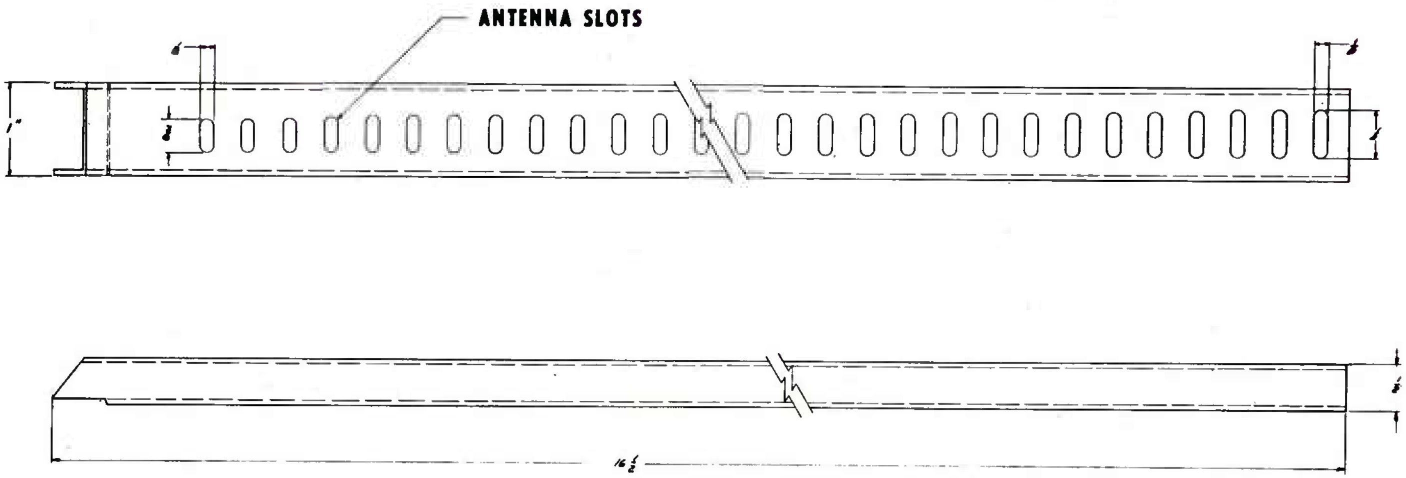

Figure 14. Slotted waveguide antenna element.

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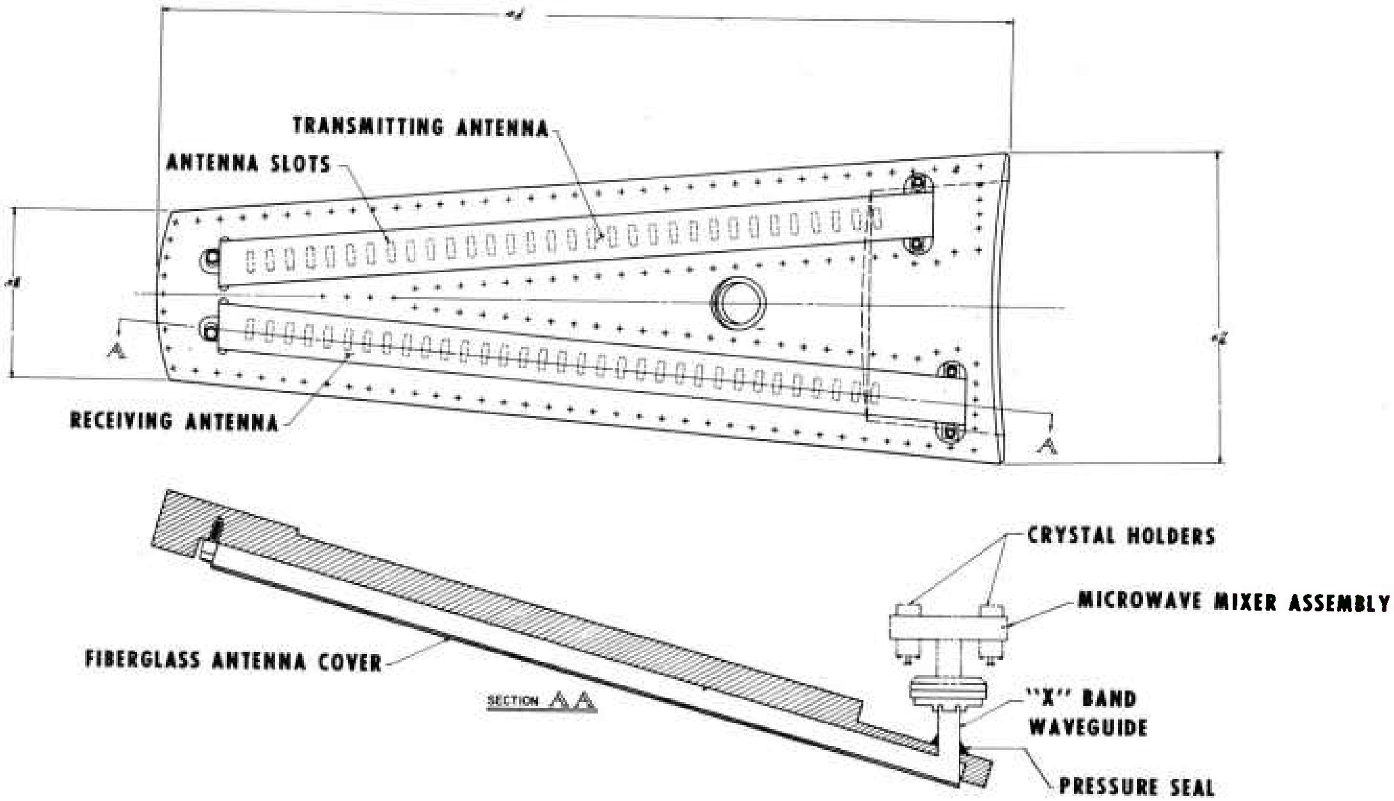

Figure 15. Antenna assembly.

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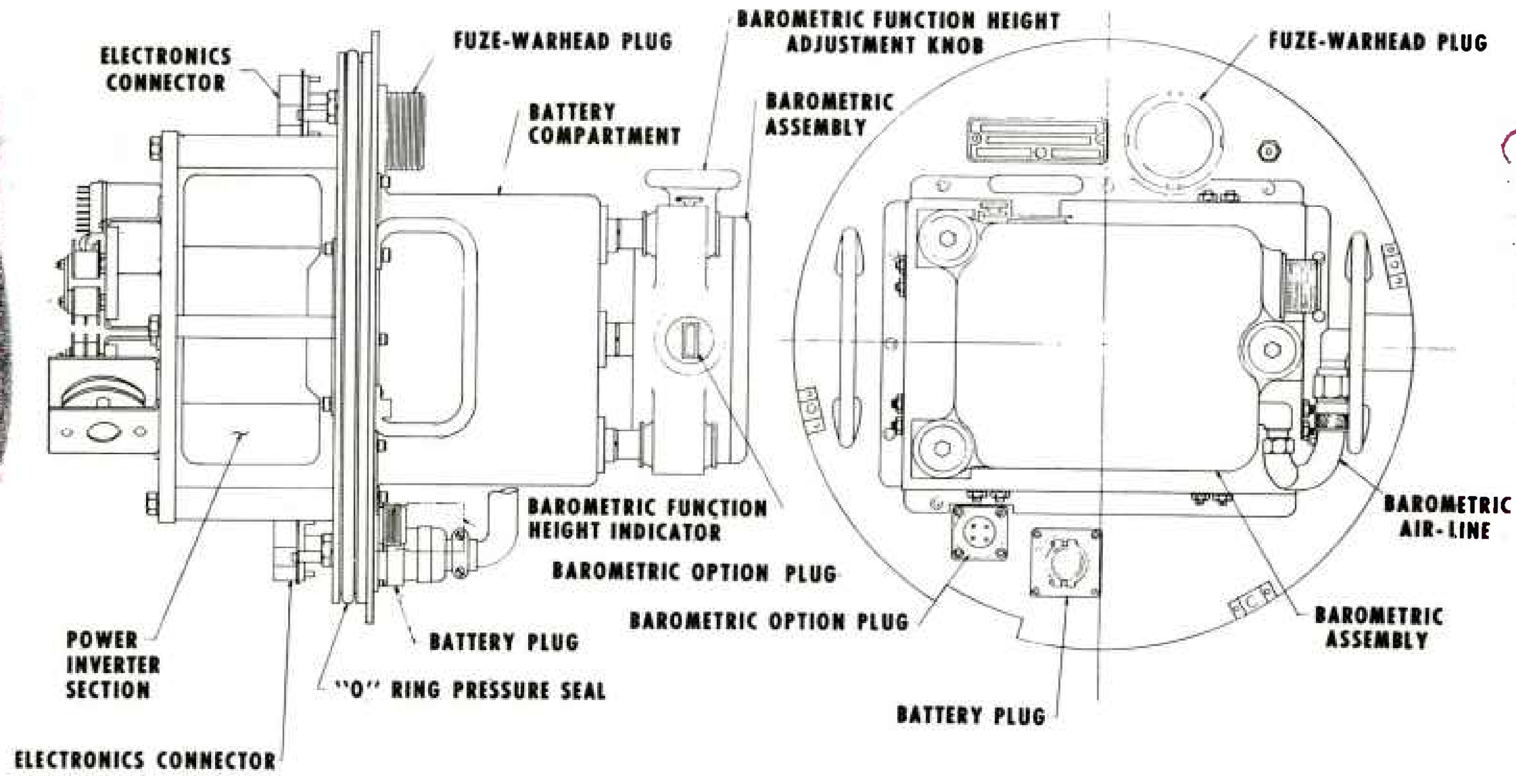

Figure 16. Barometric assembly, power-unit assembly, and battery compartment.

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connections and contacts. The weight of the unit is approximately 6 pounds. An air-line connects from the barometric assembly through the nose cone to the pressure probe located at the tip of the cone.

An option plug is provided on the base plate (Figure 16) to permit selection of either the electronic system or the barometric assembly as the fuze.

The primary energy for each electronic assembly is supplied by independent 28-volt nickel-cadmium type batteries that are contained in the battery compartment.

The major components of the power unit are: 2 rotary inverters, a rotary power switch, 6 filter capacitors, 2 power transformers, 2 filter chokes, 2 selenium-bridge rectifiers, and 2 late-arming relays.

The integral assembly (Figure 16), weighing approximately 59 pounds, bolts to the base of the "A" section. Pressure is maintained inside the "A" section by the "O" ring pressure seals.

The electrical connections from the battery compartment to the power-inverter section are made through a pressurized connector located on the base plate. Two quick-disconnect connectors provide the electrical-power connections to each electronic assembly. The electrical connections from the electronic assemblies to the warhead-fuze cabling are made through the quick-disconnect type connectors and a pressurized fuze-warhead plug. Appropriate connections to the telemeter package, which were used during the R and D phase, also pass through this fuze-warhead plug.

An air-valve plug is provided for checking the pressure seal of the nose-cone assembly.

3.2.2 Safety and Arming System

Two safety and arming (S and A) devices of identical design, constituting the S and A system, are located in the warhead.

An assembled S and A unit is shown in Figure 19. This unit is approximately 8 inches in length and 3 1/4 inches in diameter, over all. Its weight is approximately 5 pounds. Electrical connections are brought out through a single plug.

From a functional standpoint, the two major divisions of the fuze are the nose-cone assembly and the safety and arming system. The nose-cone assembly contains all equipment necessary to sense the correct function height and provide a firing pulse at this height. The S and A system provides the necessary safety, readies the fuze to function after receipt of the command-arming signal, and electrically and mechanically

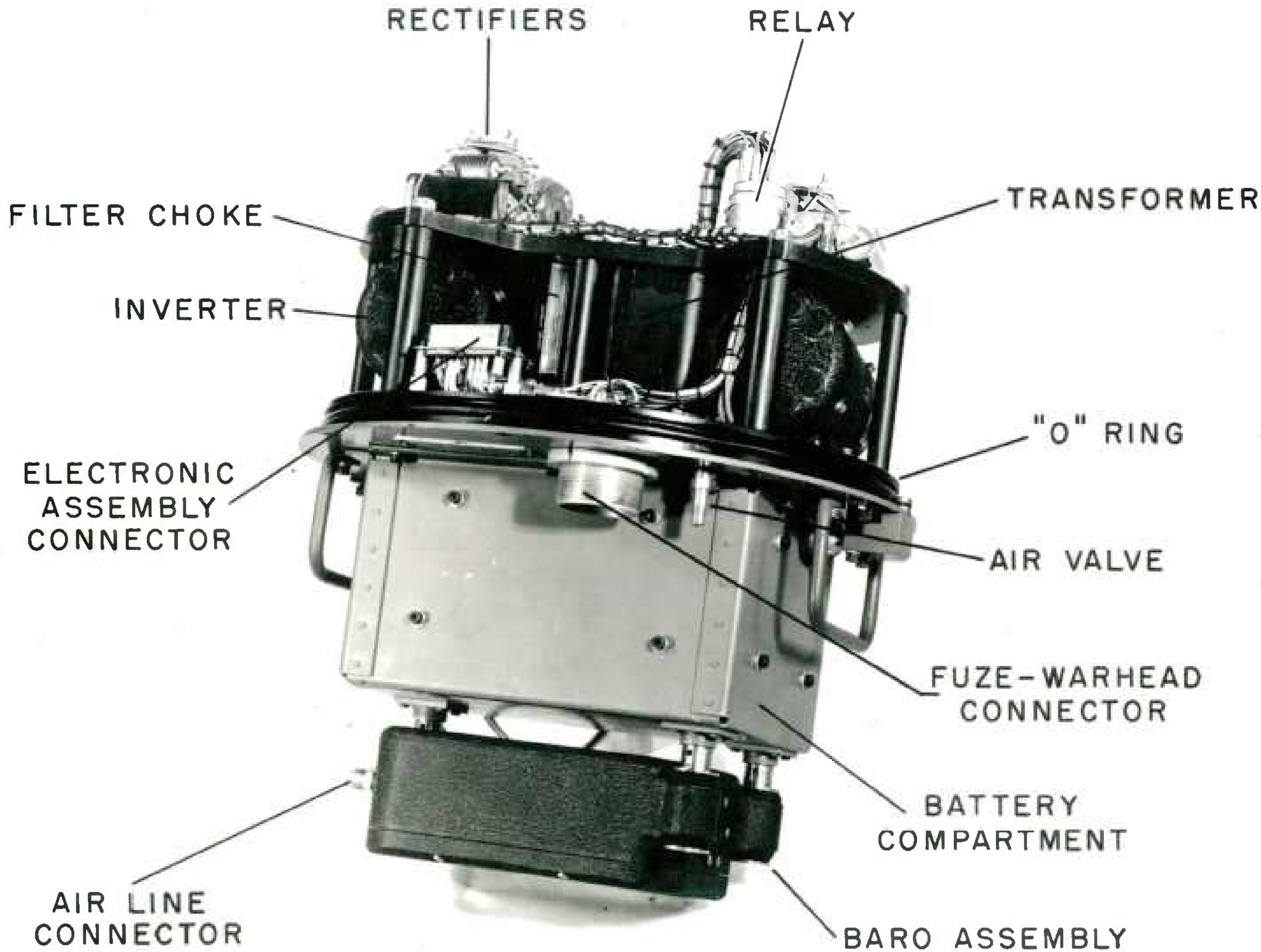

Figure 17. T3008E5 barometric assembly, power-unit assembly, and battery compartment.

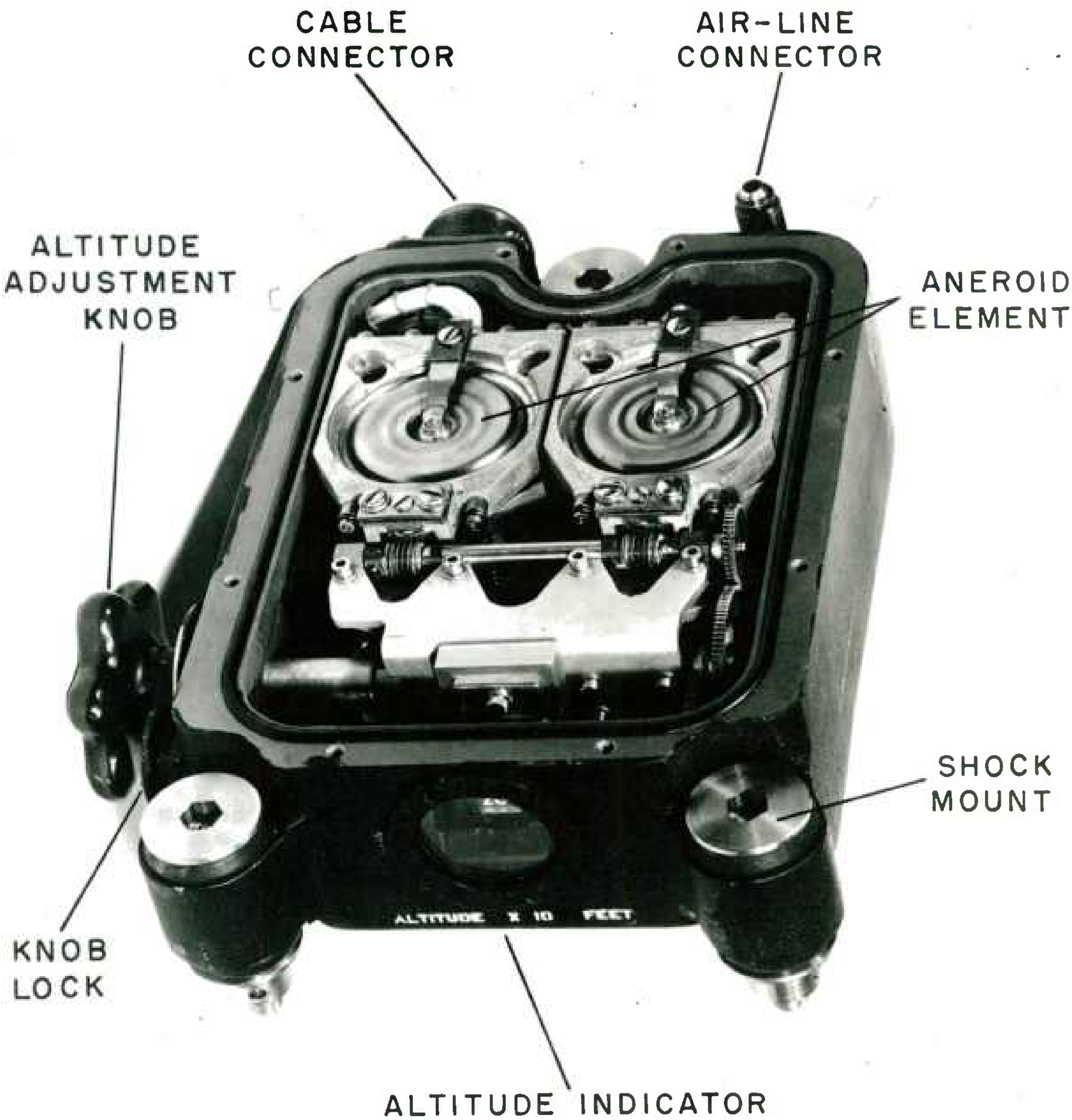

Figure 18. Barometric assembly (cover removed) for T3008E5 fuze.

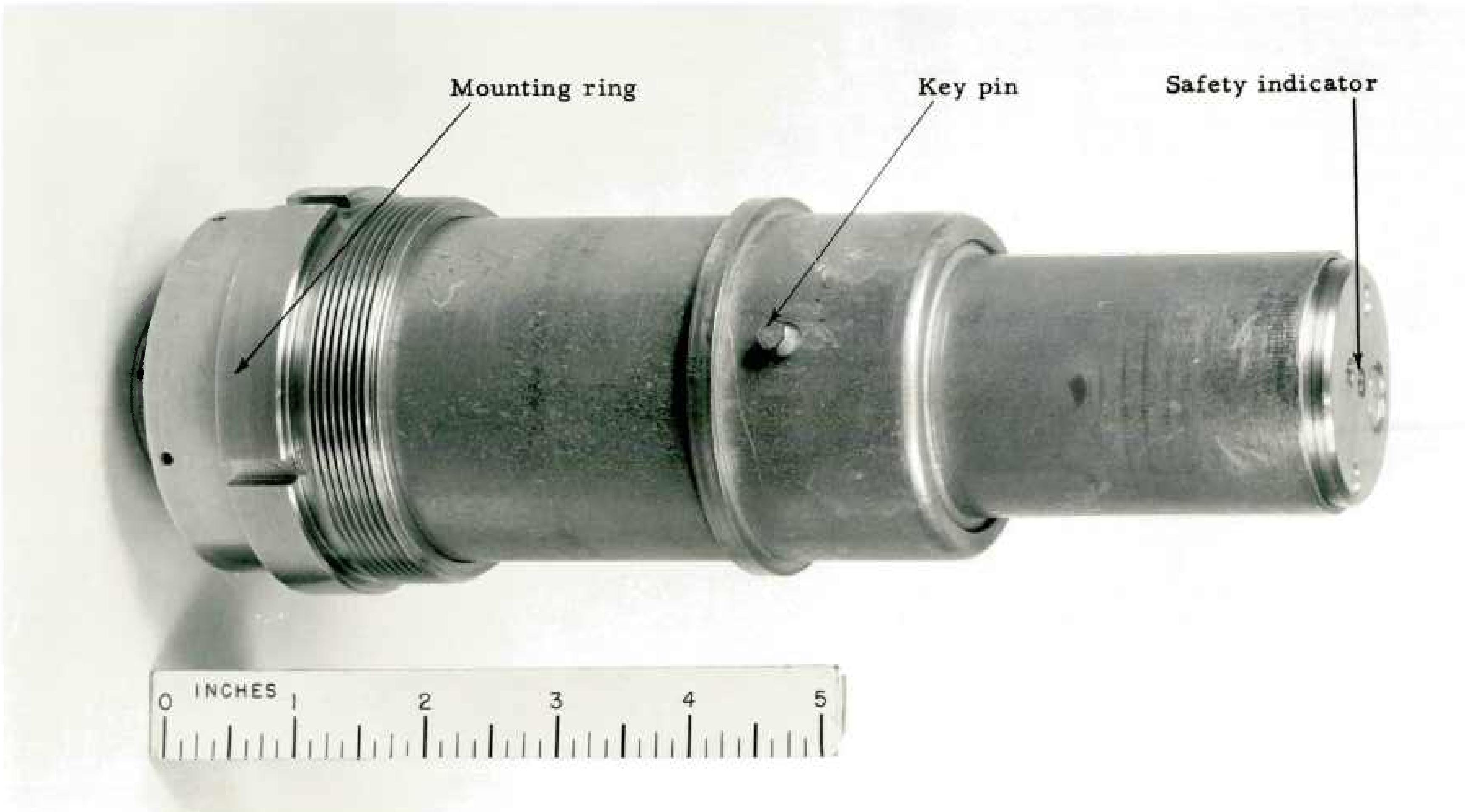

Figure 19. T3008E5 safety and arming device.

arms the explosive elements which detonate the warhead on receipt of the firing pulse.

Two electronic assemblies (primary and secondary), two safety and arming devices, and the barometric assembly are connected, as shown in Figure 20, for greater operational reliability than is possible with a single-unit fuze. The operation of either electronic assembly (or the barometric assembly if baro option is used) through either S and A device will detonate the warhead. An option circuit has been included to provide fuzing through the barometric assembly rather than through the electronic system. When the electronic system is used for fuzing, the barometric assembly provides delayed arming for the electronic assemblies.

3.2.3 Warhead-Fuze Cabling

The warhead-fuze cabling (Figures 21 and 22) provides the necessary electrical connections between the nose-cone assembly, safety and arming devices, launch equipment, command-arm equipment, and telemeter equipment (used only during R and D phases).

3.2.4 Fuze-Weight Summary

Nose-cone assembly	100 pounds
Safety and arming devices	10 pounds
Warhead-fuze cabling	7 pounds
Total fuze weight	117 pounds

3.3 Description of Operation

3.3.1 Electronic Assemblies

A functional block diagram of the electronic assemblies is shown in Figure 23. A frequency-modulated signal is generated by the action of the modulator and the R-1 klystron and radiated by the transmitting antenna element. The reflected signal is received on the receiving element of the antenna assembly and coupled through waveguide to a balanced mixer in the microwave head. A small amount of the transmitter output is also coupled into the balanced mixer through a directional coupler. At any given instant, the frequency of the mixer output is the difference between the frequency of the transmitted signal and the frequency of the received signal, as shown in Figure 4. The difference-frequency signal from the mixer is amplified by a band-pass amplifier which has a frequency-gain characteristic as typified in Figure 24. The output of the amplifier is coupled to a discriminator which has the characteristic shown in Figure 25. The characteristic of the discriminator is such that an approximate balance of output voltage is maintained when the spectral distribution, associated with the instantaneous difference-frequency signal, is essentially uniform over the band pass. Uniform spectral distribution exists when the distance to the target is greater than the preset function height. The amplifier and discriminator band pass is approximately from 150 kc/s to 550 kc/s. The net discriminator

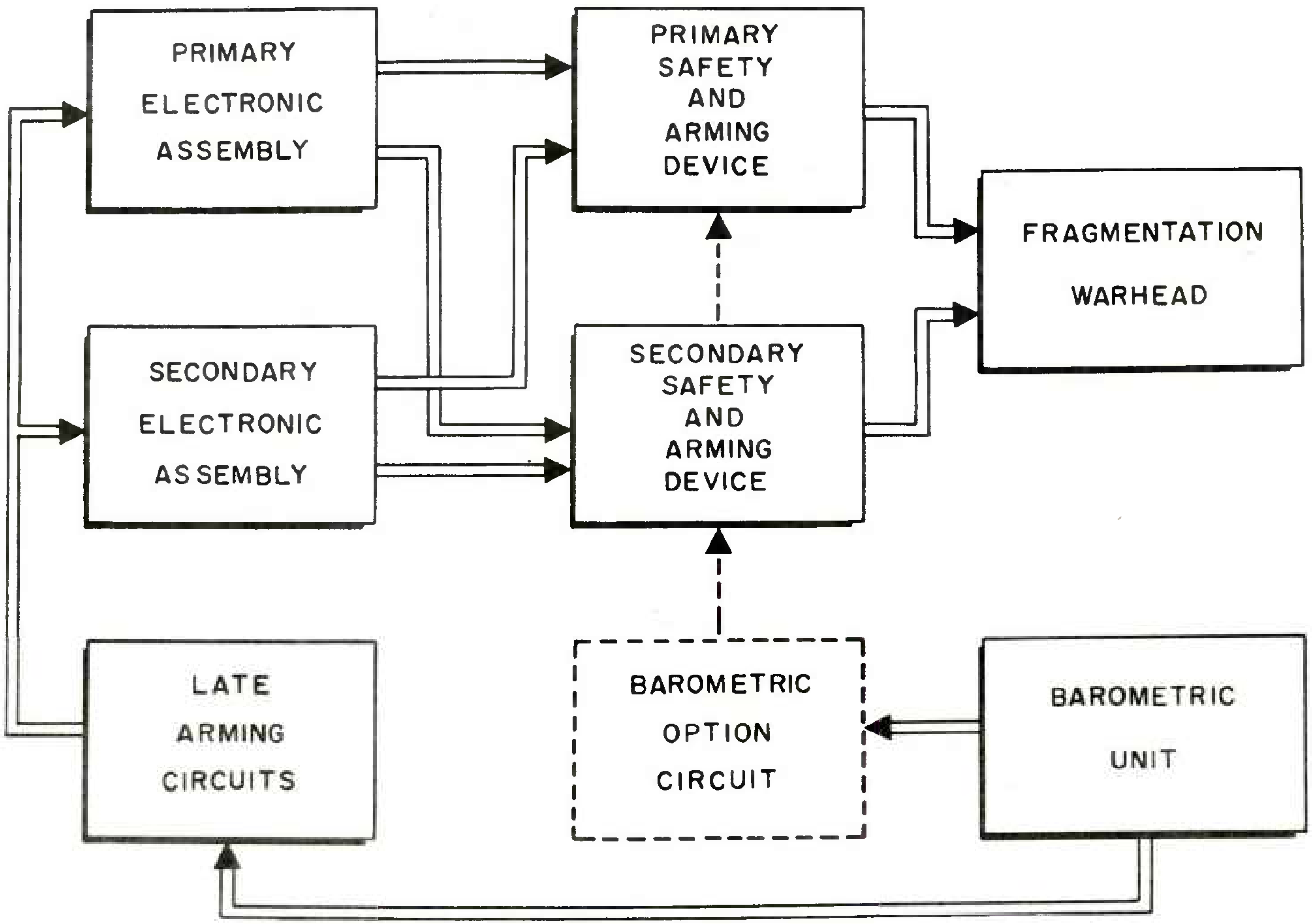

Figure 20. T3008E5 fuze electronic assembly, safety and arming device and barometric assembly block diagram.

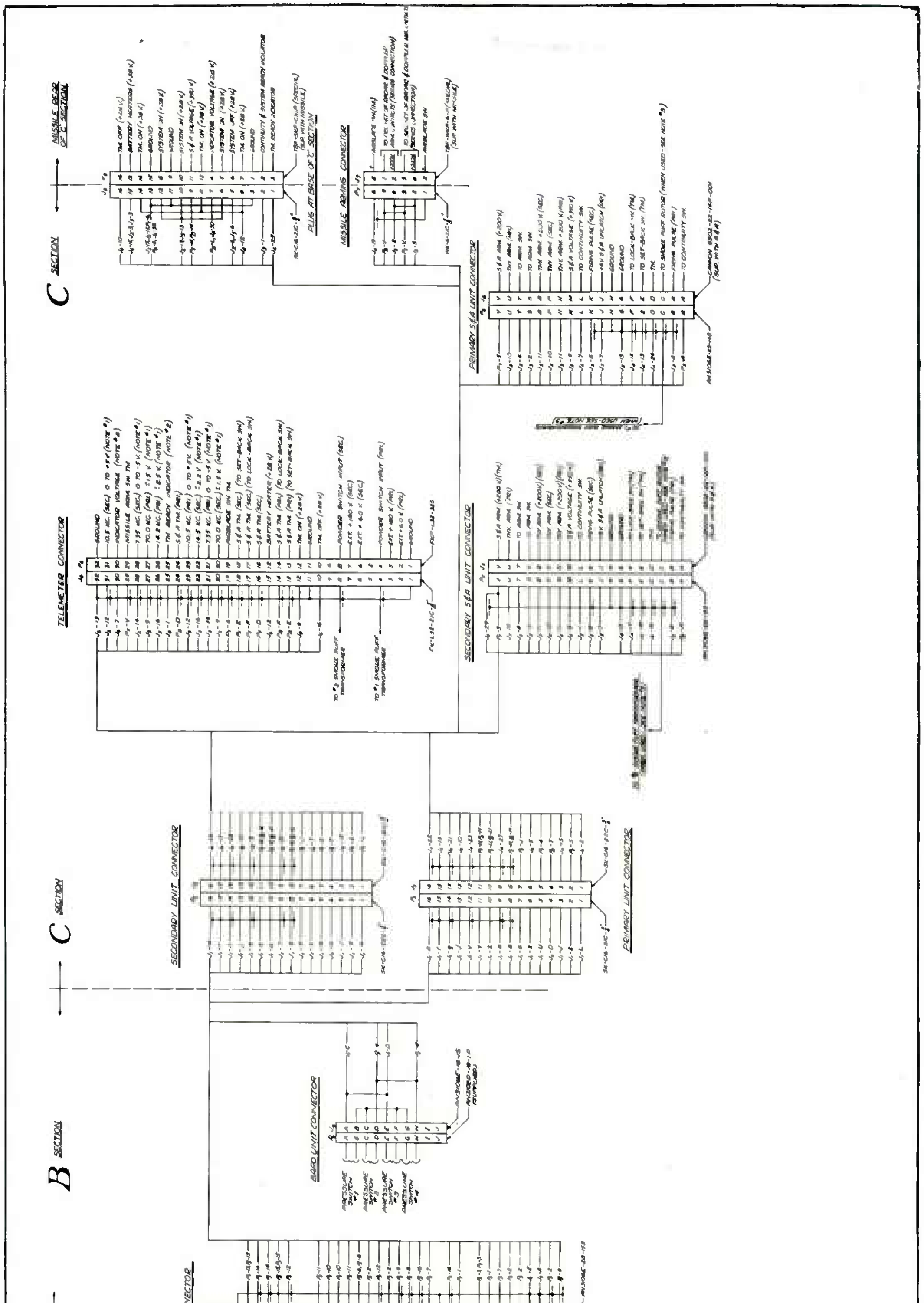

Figure 21. T3008E5 fuze-warhead cabling, schematic diagram.

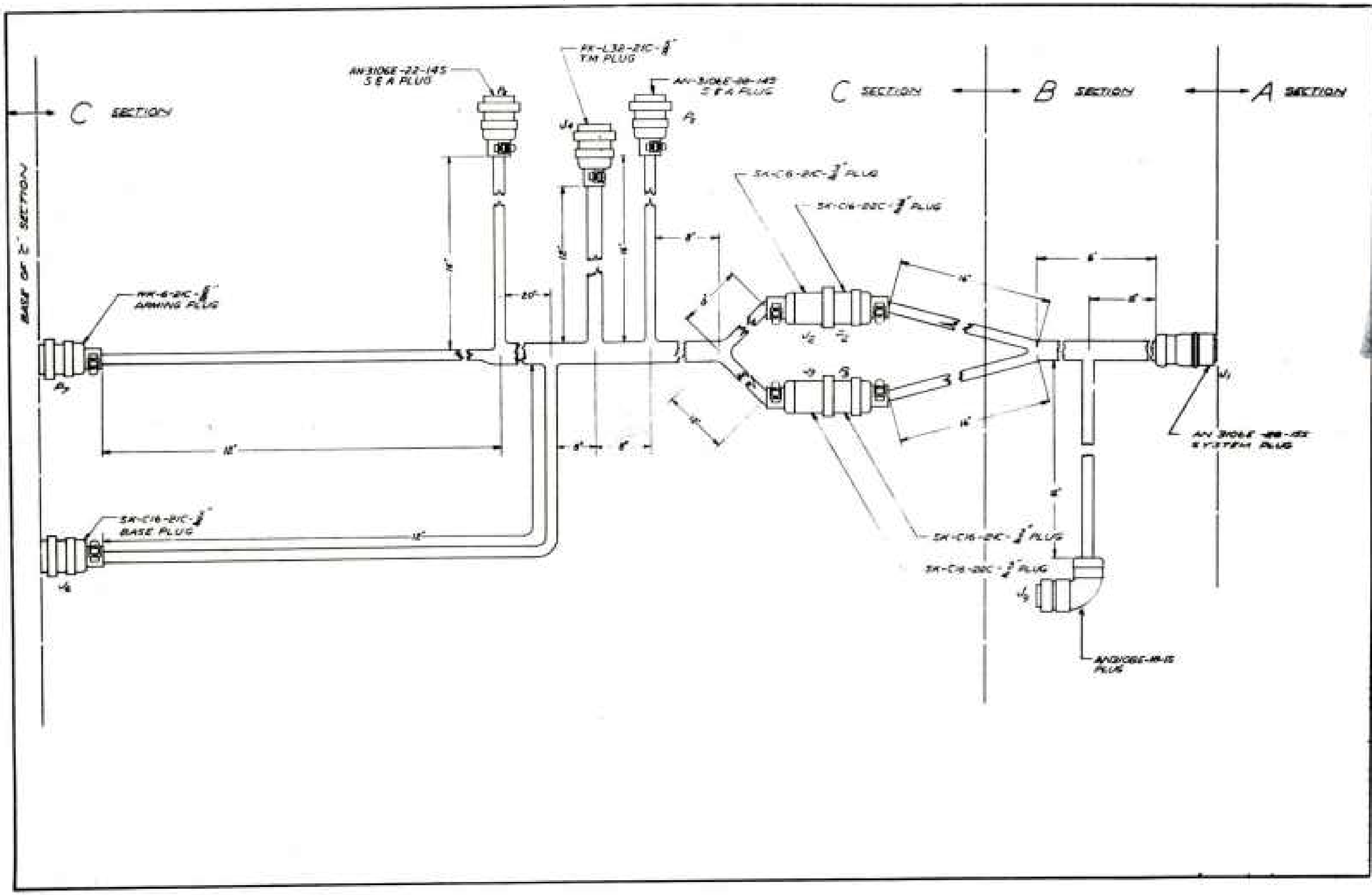

Figure 22. T3008E5 fuze-warhead cable assembly.

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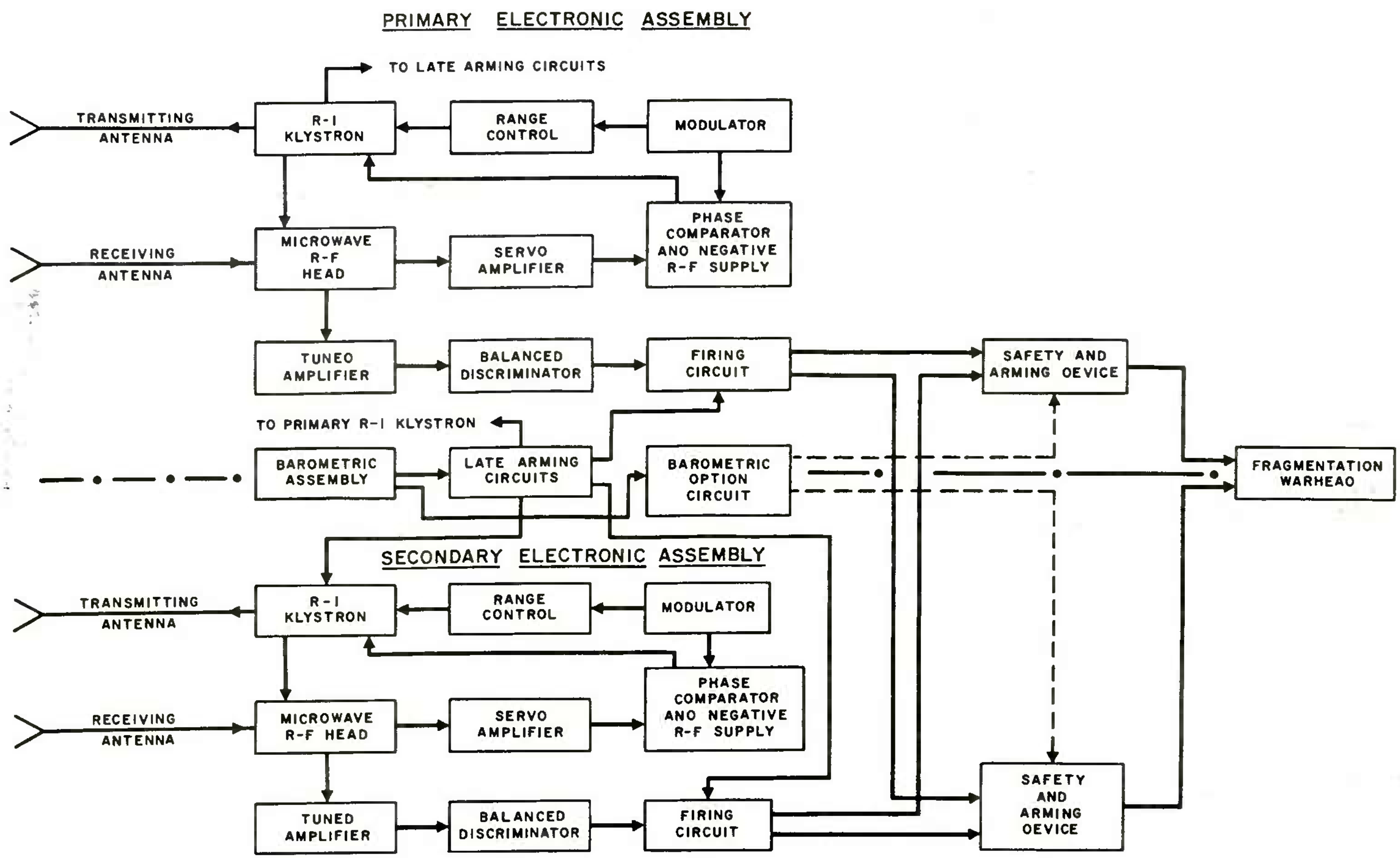

Figure 23. T3008E5 fuze block diagram.

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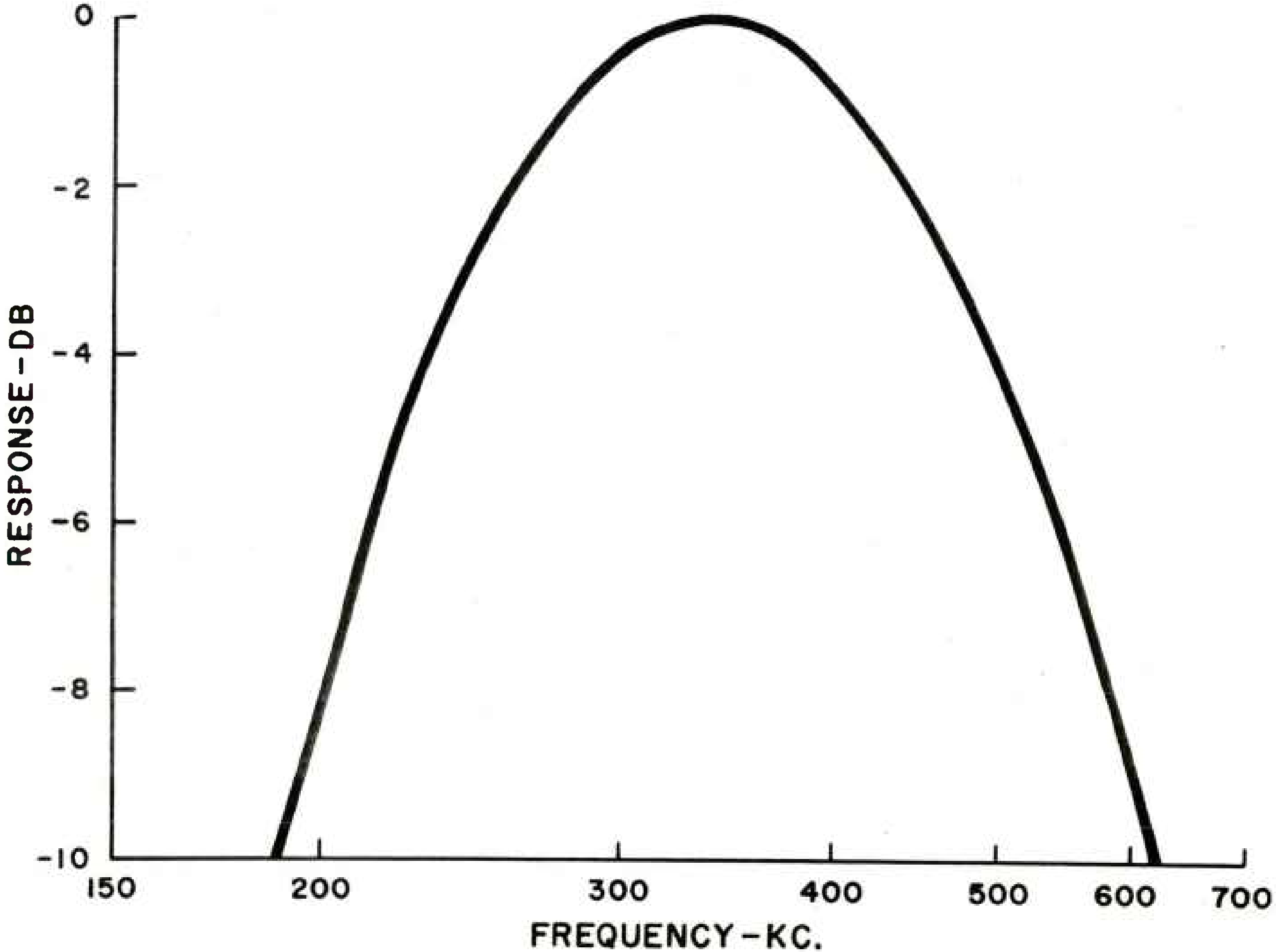

Figure 24. Receiver-amplifier frequency response.

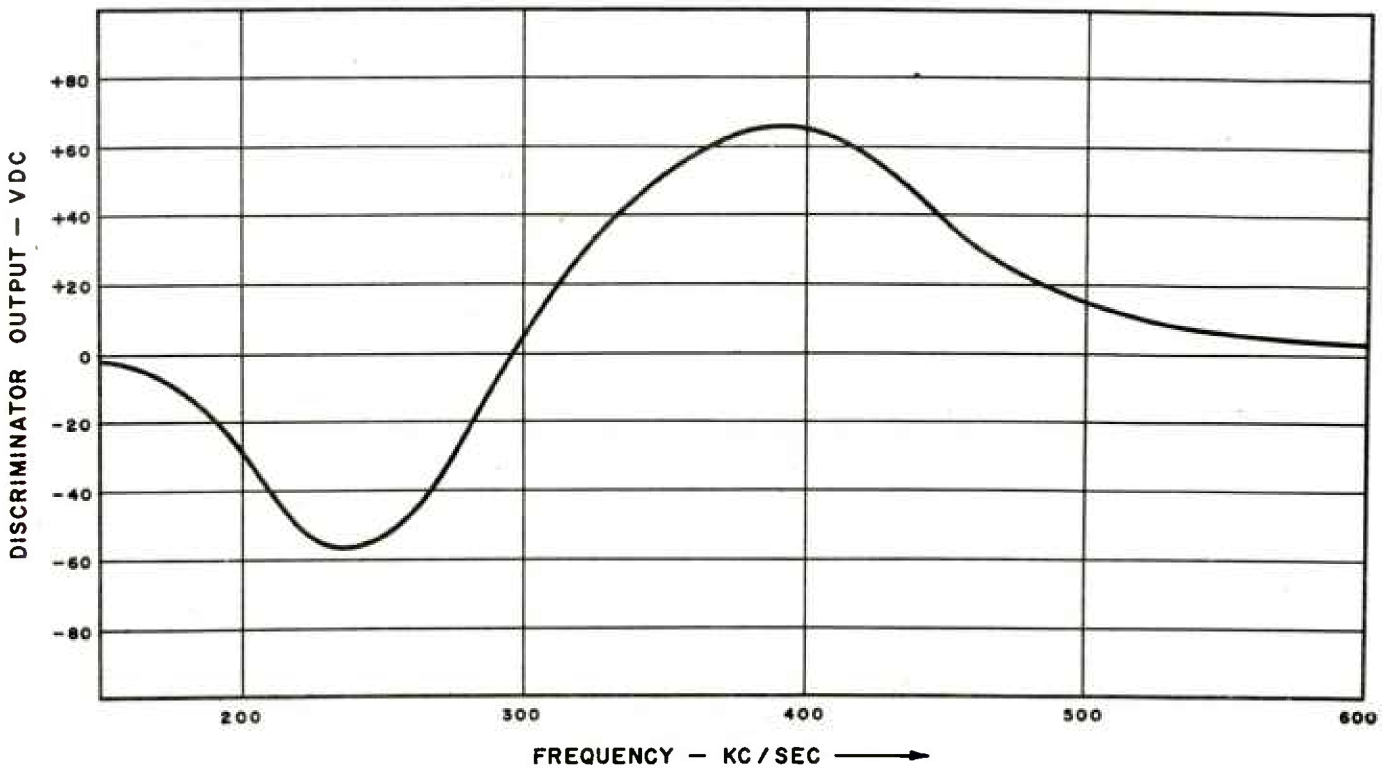

Figure 25. T3008E5 discriminator characteristic.

output is the resultant of the positive voltage produced by frequency components higher than approximately 300 kc/s and the negative voltage produced by frequency components lower than 300 kc/s.

When the missile altitude is greater than the preset function height, the discriminator output voltage is slightly positive. At the preset function height the discriminator output voltage changes from a positive to a negative value. The negative voltage is inverted and amplified by a d-c amplifier stage which is coupled to the grid of a thyratron firing circuit. The triggering of the thyratron supplies the energy to fire the detonators which, in turn, initiate action to explode the warhead.

3.3.1.1 Function Height Control

The frequency deviation of the transmitter output is proportional to the modulating voltage applied to the repeller of the R-1 klystron. Fuze function height is inversely proportional to frequency deviation. These relations make it possible to calibrate the modulating voltage in terms of function height. A single-knob, height-control potentiometer is provided to set the function height of each electronic assembly at any desired height between 75 and 1,500 feet by adjusting the klystron modulation voltage.

The height-control potentiometer is mechanically linked to the receiver-amplifier gain-control potentiometer to increase the gain as the function height is increased. The variable gain gives the required sensitivity for high function heights, and reduces the gain and the deleterious effects of klystron amplitude modulation at the higher frequency deviations (corresponding to lower function-height settings). Klystron amplitude modulation increases as the frequency deviation increases.

Two additional potentiometers (Figure 7) are mechanically linked to the height control. One of these potentiometers varies the discriminator bias further to reduce the effects of klystron amplitude modulation at the low function-height settings. The other potentiometer varies the fuze RC integration time constant between the discriminator and d-c amplifier to maintain an optimum signal-to-noise ratio. The value of the RC time constant increases as the function height is increased.

3.3.1.2 Servo Amplifier

The servo-amplifier and phase-comparator circuits (Figure 23) perform the function of maintaining the klystron at the peak of its proper mode of operation. This action is accomplished by automatically varying the d-c repeller voltage, supplied by the negative r-f supply, in accordance with the error signal developed by detecting the amplitude modulation on the klystron output and phase-comparing the error-signal voltage with the modulating voltage.

3.3.1.3 Antenna Assembly

Two independent antenna systems, each consisting of a transmitting and receiving element, are used for the dual electronic assemblies. The radiation pattern of the primary antenna system is directed so that it will be approximately normal to the earth over the range of impact angles, provided the missile is properly roll-stabilized. The radiation pattern of the secondary antenna system is directed essentially forward and parallel to the longitudinal axis of the missile, in order to prevent fuze malfunction that might occur as the result of improper orientation of the primary antenna beam when the missile is not properly roll-stabilized.

3.3.1.4 Preset Function Height for Primary and Secondary Electronic Assemblies

The primary electronic assembly is set to furnish the firing signal at the desired vertical height. The secondary electronic assembly is set to function at a vertical height which is 95 percent of that set for the primary electronic assembly. (This setting is made in terms of the slant range from the missile to the ground which is measured along a line in the direction of the maximum loop gain of the secondary antenna system.) When the missile is properly roll-stabilized (does not roll), these settings assure that the primary electronic assembly will have precedence over the secondary electronic assembly in initiating the action which results in detonation of the warhead.

The secondary electronic assembly has the opportunity of initiating the action to detonate the warhead in the event the primary assembly does not function or the missile is not properly roll-stabilized.

3.3.2 Barometric Assembly

A functional block diagram, showing the barometric assembly, is given in Figure 20. The baro unit essentially is an altitude switch consisting of four pressure elements contained within a pressure-tight housing together with associated gearing, electrical connections, and contacts (Figure 18).

The basic sensing element consists of an aneroid cell whose response is essentially linear with altitude. Each element reacts to a change of pressure independently of the others. The setting of an element is accomplished by the turning of a worm gear which drives a fine-thread screw. The worm gear of the four elements is mechanically linked with a counter-indicator and a train of gears which are in turn operated by the external single knob (Figure 18). The counter-indicator indicates height setting of the barometric assembly in feet above mean sea level. The baro unit, for the T3008E5 fuze, is presettable continuously over the altitude range from 3,500 to 30,000 feet above mean sea level.

The barometric assembly may be used either as a late-arming device for the fuze electronic assemblies or directly for optional fuzing through the S and A devices.

3.3.2.1 Electronics Option

When the T3008E5 electronic system is used as the fuzing device, the barometric assembly should be preset for approximately 3,000 feet above the desired functioning height to provide late arming and microwave turn-on. This arrangement has an excellent countermeasures features since the thyratron is not fully energized and microwave radiation is not turned on until the latest possible time. In addition the short time for fuze operation reduces the probability of early functions from any causes.

Late arming of the electronic assemblies is effected by closure of the barometric switches when the proper pressure-altitude is attained on the downward portion of the trajectory. [Normally, the barometric switches remain closed until the proper pressure-altitude is reached on the upward portion of the trajectory. However, the barometric switches are not effective during this interval since the S and A devices are not armed.]

Two late-arming, 28-volt, direct-current relays are mounted on the power-unit assembly. The barometric switches connect 28 volts from the battery compartment to the late-arming relays at the proper time. Operation of the relays applies a 200-volt, direct-current arming voltage to the firing circuit thyratron plate, and a 350-volt, direct-current potential to the klystron anode for microwave radiation turn-on.

Meteorological predictions are not required when the barometric assembly is used as a late-arming device for the electronic assemblies. The earth's sea level atmospheric pressure variation ordinarily does not exceed approximately 2.0 inches of mercury for various latitudes. This variation corresponds to an equivalent altitude variation of approximately 2,000 air feet (mean sea level ± 1,000 feet) which is well within the 3,000-foot margin allowed. (The barometric assembly is calibrated with reference to mean sea level pressure.) However, the altitude of the impact terrain above mean sea level, should be known to an accuracy of approximately ± 500 feet prior to setting the baro for arming.

3.3.2.2 Barometric Option

The barometric assembly may also be used as a fuze (Figure 20), instead of the electronic assemblies, to detonate the warhead over the altitude range of 3,500 to 20,000 feet above the target terrain (maximum terrain height of 10,000 feet). To obtain the baro fuzing option, it is necessary to insert the option plug on the "A" section base plate (Figure 7). This arrangement disables the thyratron firing circuits in the electronic assemblies. The closure of the baro switch at the preset function height activates the late-arming relay which discharges a 0.22-microfarad capacitor (previously charged to a potential of 200 volts) through the warhead detonators in the S and A devices.

Meteorological predictions are required when the barometric option is used, since greater height accuracy is desired than for arming. It has been determined that the variability of atmospheric pressure can be predicted to an accuracy of approximately 500 feet, for one standard deviation (σ), without regard for season, latitude, or longitude on the earth's surface (see Sandia Corp. Tech. Memo 160-55-51, dated 19 May 1955). If the season and position on the earth's surface are taken into account, the uncertainty can be reduced to perhaps 250 feet (1σ).

The baro height uncertainty remains essentially a fixed numerical value as altitude is varied. A 250-foot height uncertainty at 5,000 feet represents a 5-percent baro height error. Similarly, an error of 1.25 percent would occur at 20,000 feet.

The function height of the barometric assembly can be preset as low as 3,500 feet above mean sea level. A 250-foot height uncertainty at this altitude corresponds to an error of approximately 7 percent (1σ).

3.3.3 Safety and Arming (S and A) devices

The S and A device has been designed to permit safe handling of the warhead section under all environmental conditions. It will not arm the fuze until the missile is actually in flight and has traveled a safe distance from the launching site. Arming will occur only if (1) there is a launch signal, (2) the missile experiences sufficient acceleration for 30 seconds, and (3) a command-arming signal has been given.

The S and A device, shown in Figures 19 and 26, is housed in a steel cylinder. All actions necessary for arming of the warhead are automatic prior to command arming. A visual indicator shows the safe condition of the S and A device (Figure 27); inspection of this indicator is made prior to insertion of the S and A unit in the warhead well. A further check on safety can be made, if desired, by checking the series electrical continuity of three major safety switches.

As illustrated in Figure 28, the following sequential steps, indicative of launching, acceleration, command arming, and late (baro) arming occur before the S and A device arms the warhead and readies the T3008E5 fuze to send a firing signal to the detonators:

a. Charging of the tank capacitor C1 to a potential of 350 volts; this voltage is supplied from the fuze launch panel when the missile firing switch is thrown.

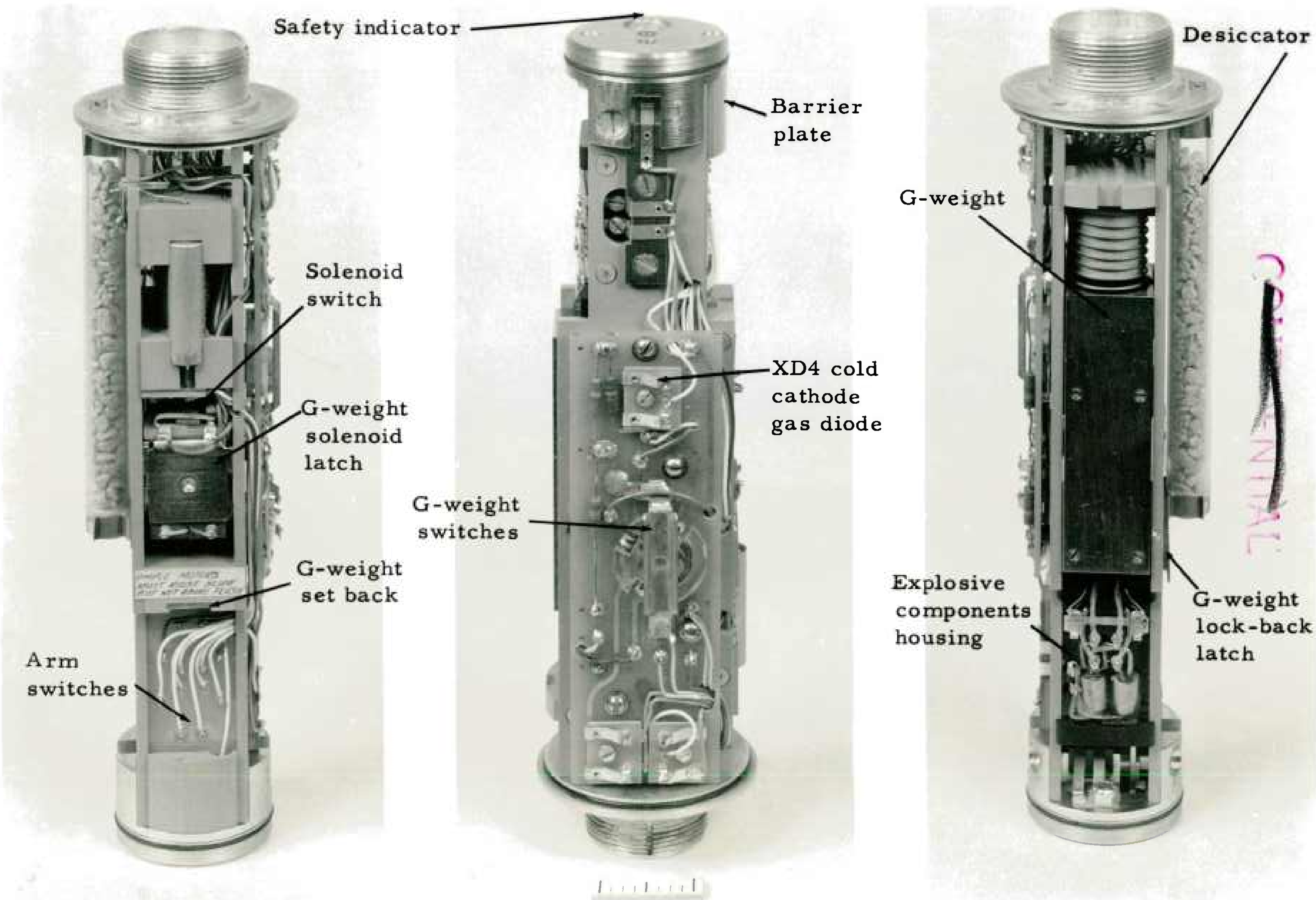

Figure 26. T3008E5 safety and arming device less housing.

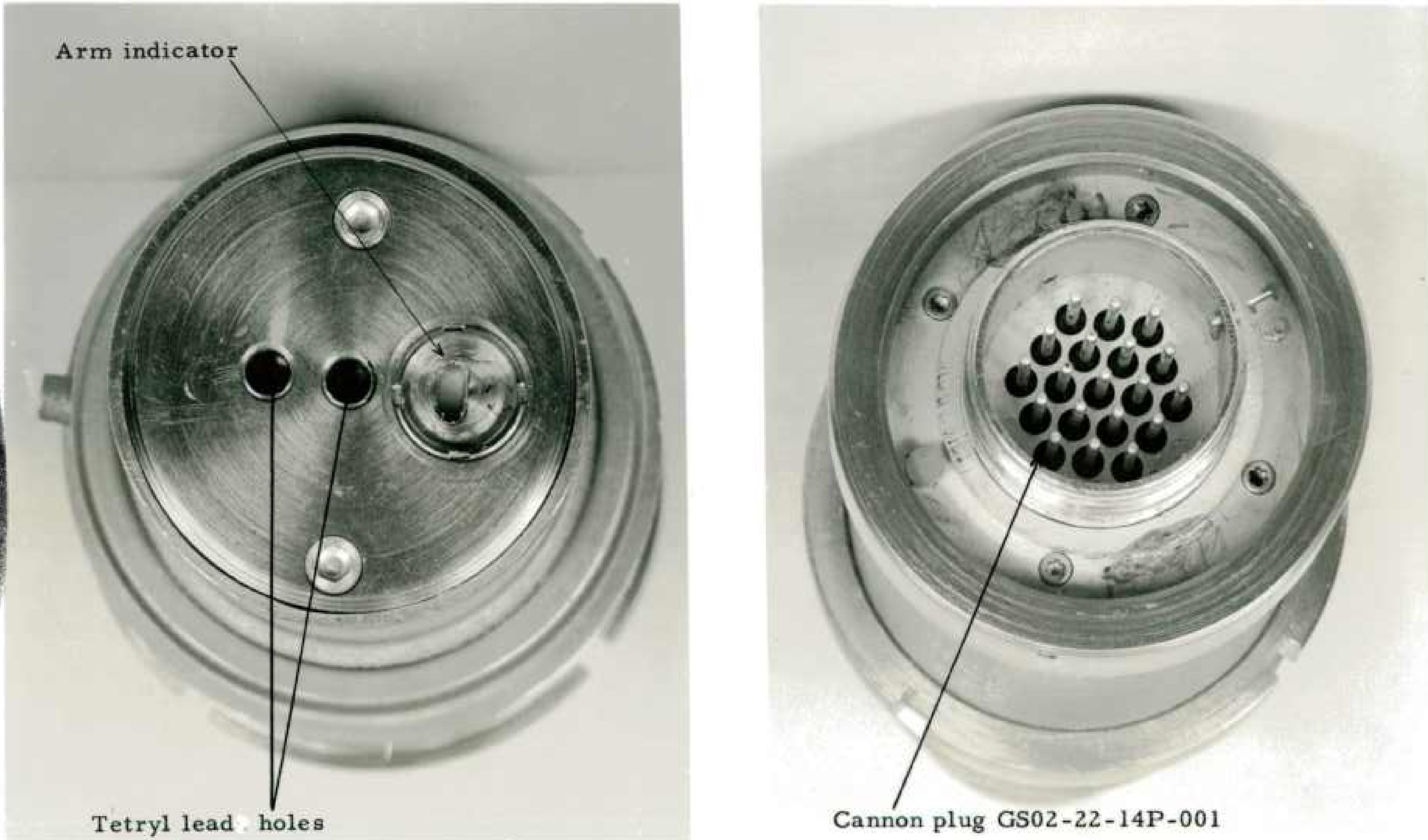

Figure 27. T3008E5 safety and arming device.

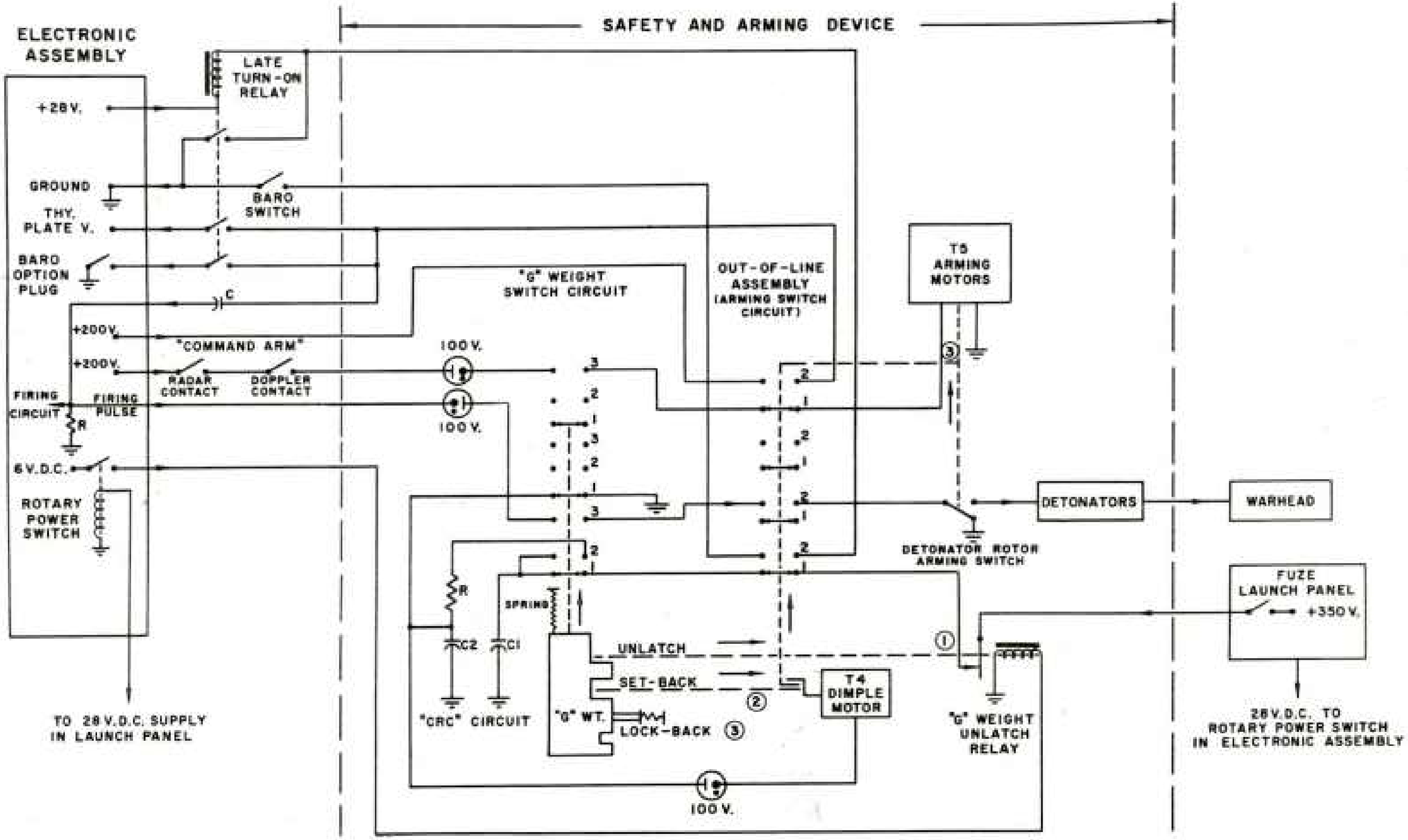

Figure 28. Functional diagram of the safety and arming device.

b. Unlatching of the G-weight in the S and A device; five seconds prior to lift, 6 volts from the fuze internal battery supply is applied to the S and A unlatch solenoid. Simultaneously, the 350-volt charging voltage from the fuze launch panel is disconnected through a contact on the unlatch relay.

c. Moving of the G-weight under the influence of 0.5 g net acceleration; this acceleration must continue for 30 seconds. The G-weight switch moves from position 1 to position 2. The S and A tank capacitor C1 begins to discharge into the capacitor C2, through the resistor R. At the end of 30 seconds, after the G-weight switch closure, the potential across the capacitor C2 has increased to a value large enough to discharge the necessary energy through a 100-volt gas diode; this energy activates the explosive dimple motor T4.

The operation of the dimple motor allows the G-weight to move from position 2 (setback) to position 3 (lockback) where the G-weight remains in a latched condition. The out-of-line detonator assembly is also unlatched by the dimple-motor action. An electrical connection from the command-arm switches to the T5 arming motors is made when the G-weight switch is in position 3. The safety and arming device is now ready for final arming by command.

d. Closing of the radar and Doppler command arm switches; this action supplies energy from the 200-volt, d-c circuit to the T5 arming motors. These motors rotate the out-of-line detonator rotor to the in-line position 2, connecting the warhead detonators to the fuze firing circuit.

e. Closing of the barometric-assembly altitude switches; the baro switches are normally closed on the ground. However, they are not effective then since the baro is connected in series with the S and A devices. The baro switches open as the missile ascends. At command arm, an S and A switch in series with the baro closes. The pressure-altitude is such that the baro switches are open at this time. The baro switches close on the downward portion of the trajectory at the desired height (Figure 3). Closing of these switches applies 200 volts dc to the plate of the firing-circuit thyratron for late arming and 350 v dc to the klystron anode for microwave radiation turn-on at approximately 3,000 feet above the preset height of the electronic assemblies.

When the baro option circuit is used for fuzing, warhead detonation is controlled directly by means of the barometric assembly through the S and A devices.

3.4 Field Equipment

The following waterproof field equipment is required for the T3008E5 fuze: battery charger, Go, No-Go panel, and launch panel, (Figures 29, 30, and 31).

Figure 29. Battery charger.

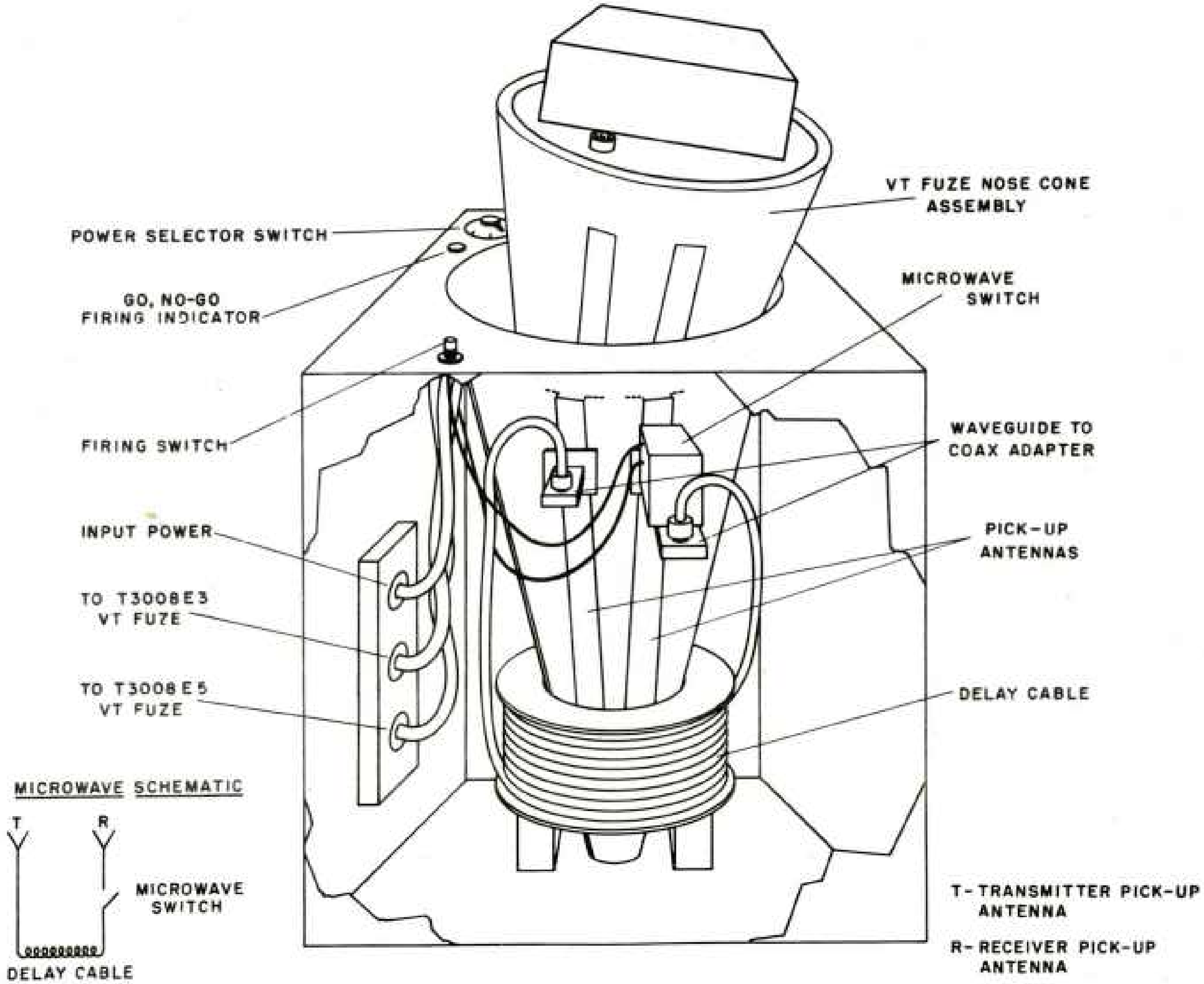

Figure 30. Go, No-Go test unit.

The battery charger is required to charge the nickel-cadmium batteries in the battery compartment. The nose-cone assembly is checked at the launch area with the Go, No-Go test panel. This panel permits a rapid check of the operability of the fuze circuits. The launch panel is required to launch the T3008E5 fuze. Detailed instructions for operating the field equipment are contained in DOFL report No. TR-E-105, "Operation and Field Handling Procedures for T3008E5 Fuze".

In addition to the above field equipment, a Go, No-Go baro test panel is required for the barometric assembly. This device, when connected to the barometric assembly, reduces pressure in the baro to simulate increasing altitude. Decreasing altitude can also be simulated. Closure of the altitude switches in the baro will turn on a series of indicator lights on the front panel of the test set to simulate function. A photograph of an R and D model baro Go, No-Go test panel is shown in Figure 32. Simulated altitude, above mean sea level, is indicated directly in feet on a meter. Pressure reduction is obtained with a hand-operated crank (Figure 32).

3.5 Assembly

The T3008E5 nose-cone assembly, the two safety and arming devices, and the warhead-fuze cabling are mounted respectively in the "A", "B", and "C" sections of the Corporal missile.

The warhead-fuze cabling is installed and secured with appropriate cable clamps in the "B" and "C" sections. After installation of the cabling, the two safety and arming devices are installed in the warhead wells shown in Figure 2. The appropriate warhead-fuze cabling connections are then made to the nose-cone assembly and the S and A devices. The barometric probe is attached to the tip of the nose cone (Figure 7).

The nose-cone assembly (Figure 10) is hinged to the "B" section of the Corporal missile by means of two eyebolts. The insertion of three additional bolts completes the mating of the nose-cone assembly to the "B" section.

3.6 Maintenance

The nose-cone assembly is checked at the launch area with the Go, No-Go test panel. This unit consists of a lossy delay line that can be shorted at one end to simulate a target, pickup antennas, a control switch, and a firing indicator. If the firing indicator does not light during the above test, a defective nose-cone assembly is indicated. The baro Go, No-Go test panel is used to test the barometric assembly. Rejected assemblies are forwarded to the maintenance area for repair.

The service test set is used in the maintenance area to service any nose-cone assembly found to be defective. The service test set shown in block diagram form in Figure 33, is used in the maintenance area to check fuze calibration and major fuze assemblies.

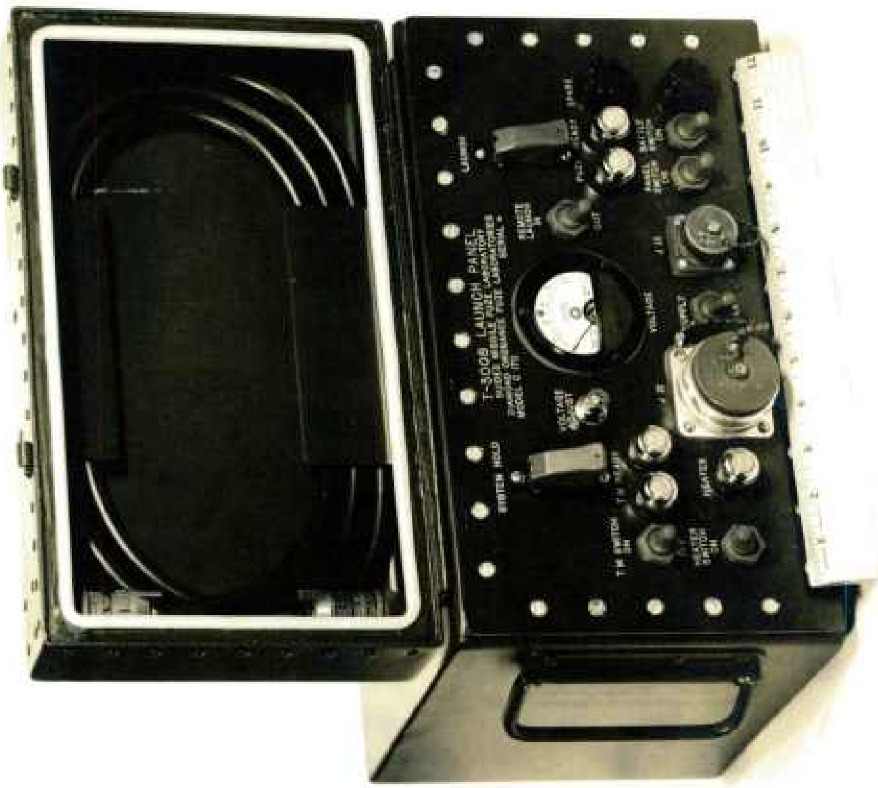

Figure 31. Launch panel.

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Figure 32. Barometric assembly Go, No-Go test panel.

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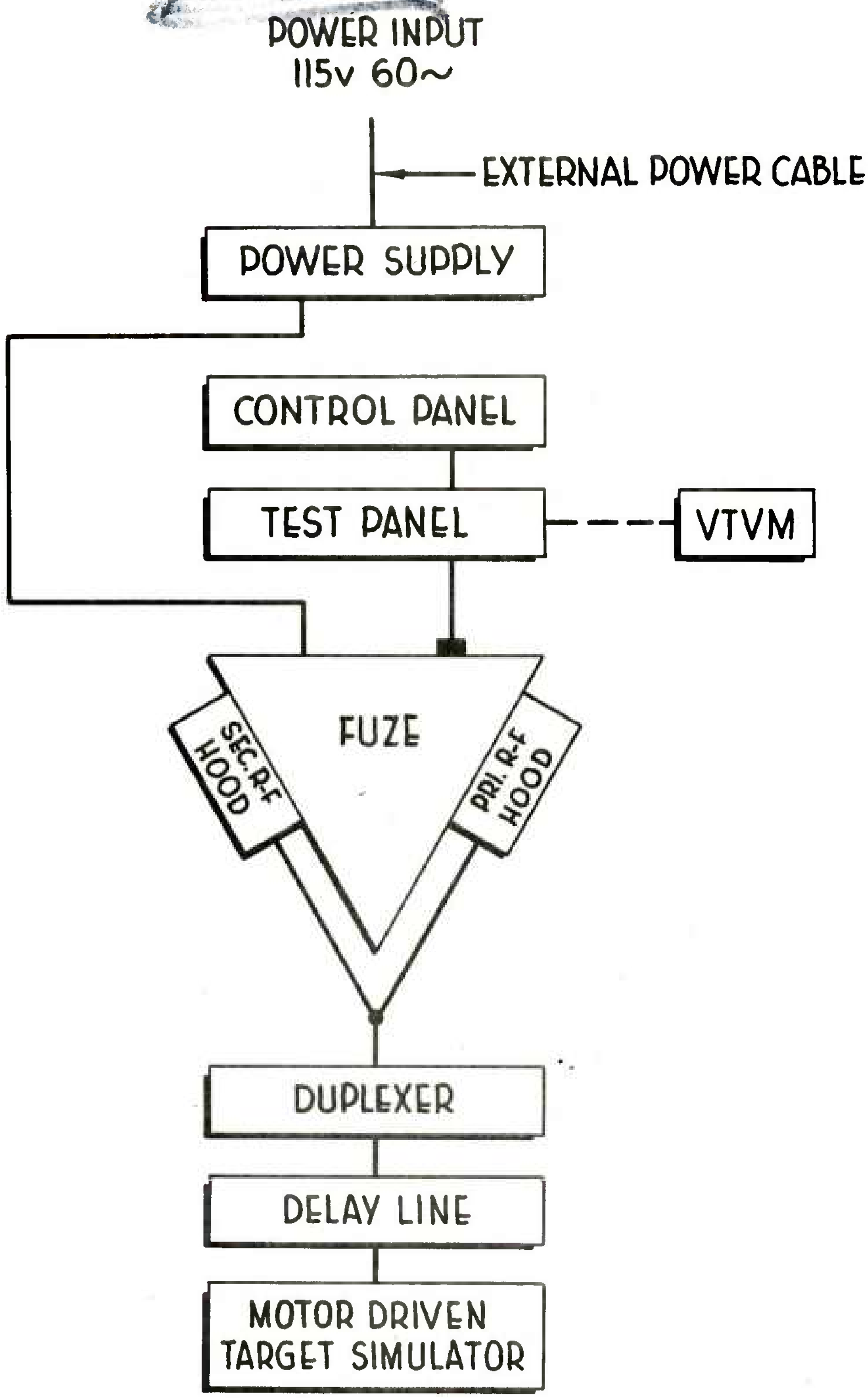


Figure 33. Block diagram of T3008E5 service test unit.

The detailed operating and maintenance instructions required for the T3008E5 fuze electronic assemblies are similar to those contained in the manual "Maintenance Instructions for Nose-Cone Assembly of T3008E3 Fuze System" (DOFL Report No. TR-E-196). This manual describes the step-by-step test procedure for the location and replacement of defective major units in the nose-cone assembly.

3.7 Tools and Accessories

There are no special tools supplied with the T3008E5 fuze. The tools that are required to disassemble a rejected nose-cone assembly will be provided in the service test set.

Each T3008E5 fuze is supplied with a fuze log. The log carries the same serial number as the fuze which it accompanies and includes manufacturing test data, space for recording repairs, modifications, field-test data, and accumulated time of operation. The log is inclosed in a protective container.

3.8 Design Characteristics of Engineering Models

Four different models were fabricated and tested prior to the design of the E5 model. The successive models incorporated major improvements in electrical and/or mechanical characteristics as outlined briefly below:

Model

T3008E0 - HOUSING - Consisted of an inner conical structure and outer conical structure. Only the inner cone was pressurized.
CIRCUITRY - First adaptation of Corporal fuze circuit. Single electronic unit mounted inside of inner cone structure. Horn-type microwave antennas were used. Circuitry consisted of combination dynamotor and silver-cell-battery power supply, unidirectional discriminator, RC-coupled amplifier, and flexible waveguide.
S and A - RC -type.

T3008E1 - HOUSING - No change from T3008E0.
CIRCUITRY - Eliminated horn-type antenna and incorporated slotted antenna. Substituted a balanced discriminator and a series-type amplifier, for the unidirectional discriminator and the RC-coupled amplifier, respectively. Used dual electronic units for greater operational reliability.
S and A - RC-type.

T3008E2 - HOUSING - Eliminated the inner cone. Outer cone structure changed to accommodate dual electronic units and solid waveguide assembly.
CIRCUITRY - Mercury cells replaced dynamotor.
S and A - RC-type.

T3008E3 - HOUSING - Structural changes to allow skin mounting of dual electronic units.
CIRCUITRY - Eliminated mercury-cell batteries and substituted speed-controlled inverter and 28-v/6v nickel cadmium battery pack. Rearranged power deck assembly. Incorporated a height-adjustment control and a gain control which are mechanically linked.
S and A - RC-type.

T3008E5 - HOUSING - No change from T3008E3.
CIRCUITRY - Similar to T3008E3 except as follows: Higher d-c amplifier gain, adjustable discriminator bias voltage, and variable integration time control included. Modulation frequency 20 kc instead of 30 kc. Barometric assembly, for late-arming and fuzing option, has been added. A 28-v nickel-cadmium battery replaces 28-v/6-v battery combination.
S and A - RC-type.

4. ELECTRICAL DRAWINGS

The following electrical drawings define the circuit parameters of the T3008E5 fuze.

Number	Title
Figure 34	Schematic Diagram of Fuze T3008E5
Figure 21	T3008E5 Fuze-Warhead Cabling Schematic Diagram
Figure 35	T3008E5 Safety and Arming Device Schematic Diagram
Figure 22	T3008E5 Fuze-Warhead Cable Assembly

A complete set of mechanical and electrical drawings (approximately 200 in number), which were prepared during the program, are available. Additional information is contained in reports referenced in the bibliography.

5. PROPOSED ELECTRICAL AND ENVIRONMENTAL SPECIFICATIONS FOR THE T3008E5 FUZE

The following specifications are based on the results of laboratory and field measurements on T3008E5 engineering models and have been the criteria for acceptance of the models tested in the evaluation program.

5.1 Scope

This specification covers the electrical and environmental performance requirements for the Fuze, Guided Missile, Proximity, T3008E5 for the Corporal XSSM-A-17 surface-to-surface missile.

5.2 Electrical Specifications for Nose-Cone Assembly

5.2.1 Antennas

5.2.1.1 Primary Antenna Assembly

5.2.1.1.1 Primary Radiation Pattern

The one-way radiation pattern of each antenna in the primary fuze shall have the maximum radiation directed $30^\circ \pm 3^\circ$ downward from the missile axis. This angle is noted as Θ in paragraph 5.2.1.4.

5.2.1.1.2 Gain

At the maximum radiation point of the pattern, the minimum gain shall be 15 db (relative power one way) above isotropic. The gain shall be less than isotropic for all angles not included within $\pm 15^\circ$ from the point of maximum radiation.

5.2.1.1.3 Beam Width

The narrow cross-sectional beam width of each antenna in the primary fuze shall be $10^\circ \pm 2^\circ$ at the 3-db points.

5.2.1.2. Secondary Antenna Assembly

5.2.1.2.1 Secondary Radiation Pattern

The one-way radiation pattern of each antenna in the secondary fuze shall have the maximum radiation directed $7.5^\circ \pm 2^\circ$ above the missile axis. This angle is noted as Θ in paragraph 5.2.1.4.

5.2.1.2.2 Gain

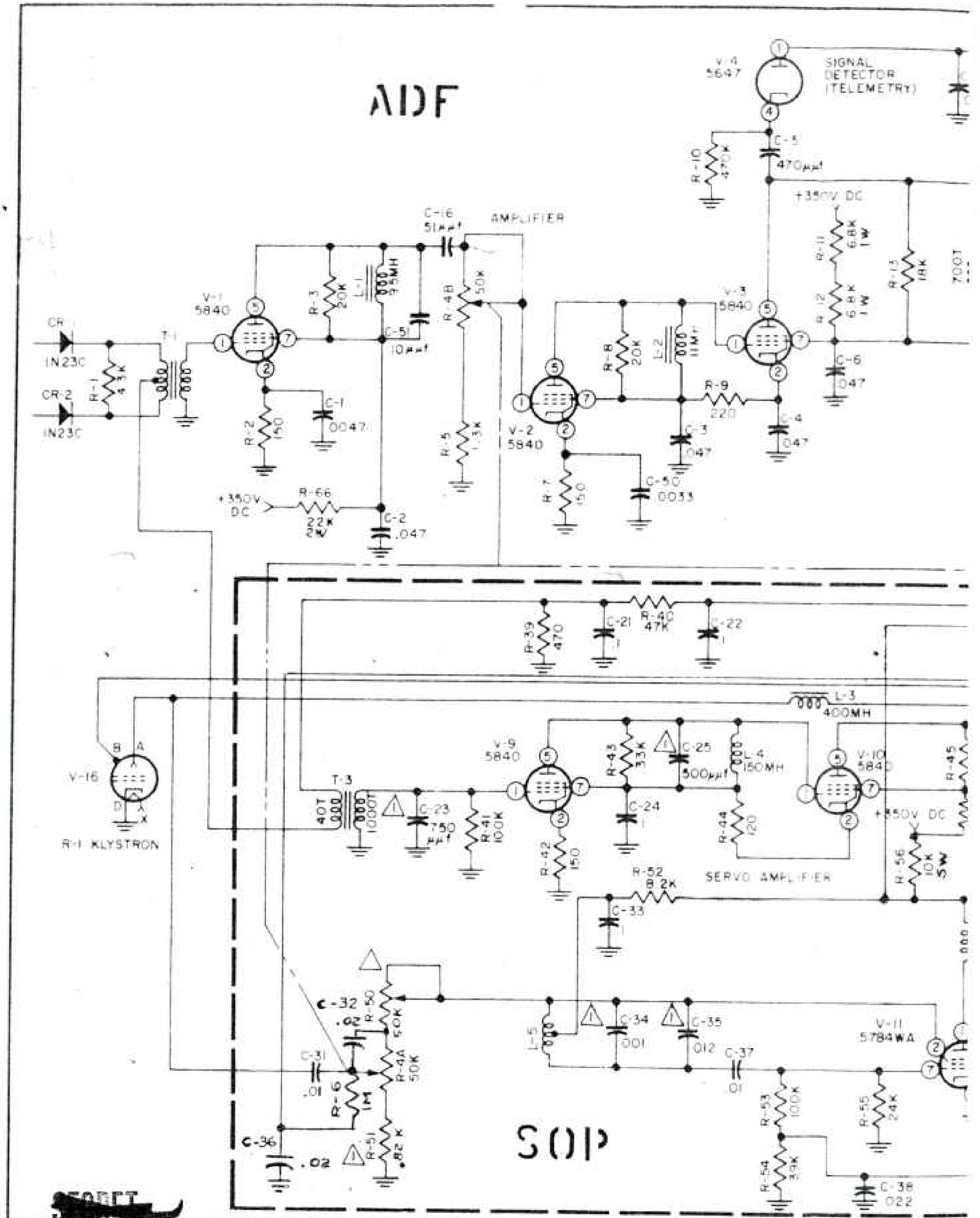
At the maximum radiation point of the pattern, the minimum gain shall be 14 db (relative power one way) above isotropic. The gain shall be less than isotropic for all angles not included in the angle $\pm 30^\circ$ from the missile axis.

5.2.1.2.3 Beam Width

The narrow cross-sectional beam width of each antenna in the secondary fuze shall be $14^\circ \pm 2^\circ$ at the 3-db points.

5.2.1.3 Voltage Standing Wave Ratio (VSWR)

The following specifications for VSWR include the effects of waveguide bends, microwave windows and, where applicable, klystron spacers for all frequencies within the band of $f_o \pm 200$ megacycles.



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A

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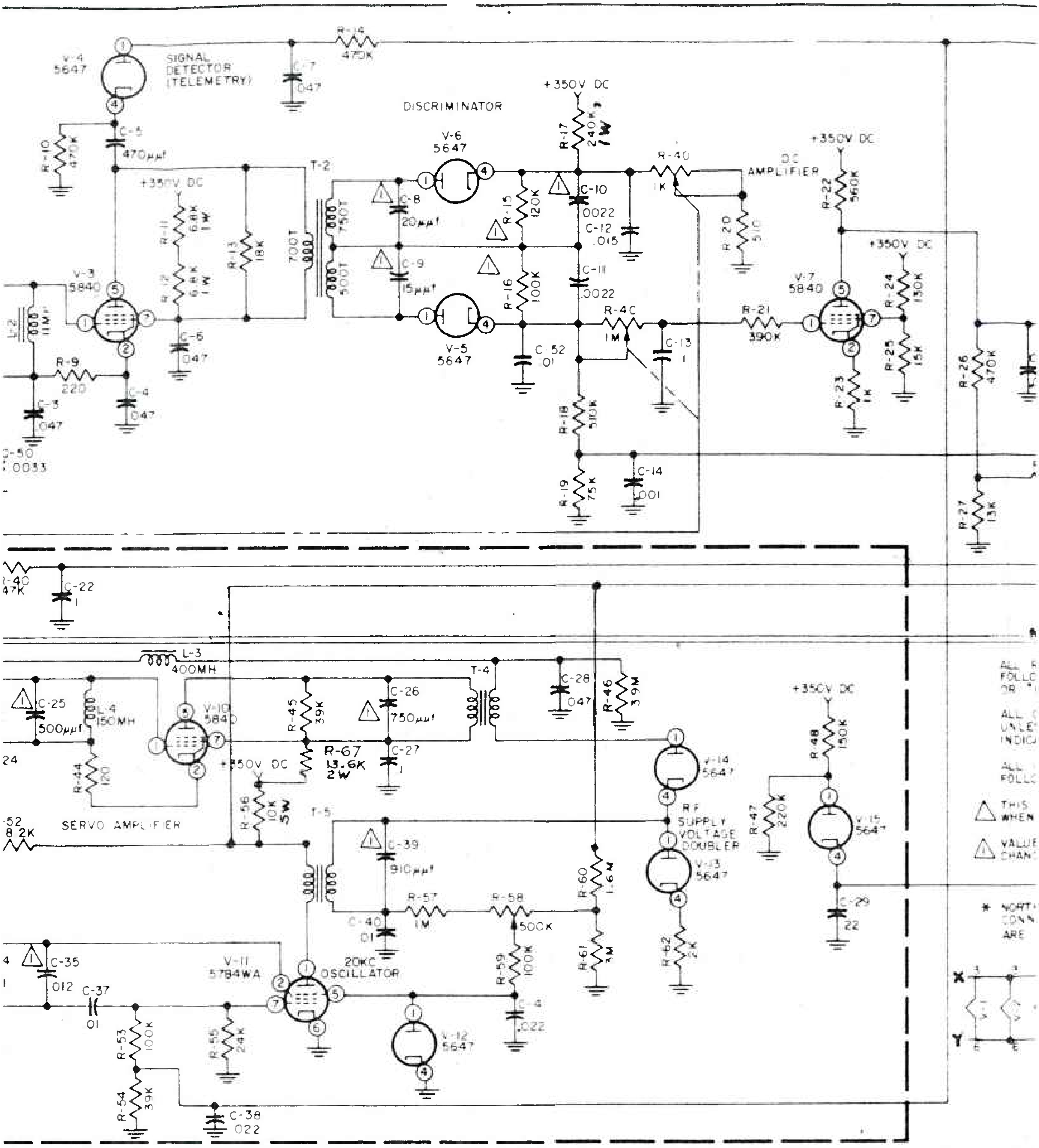
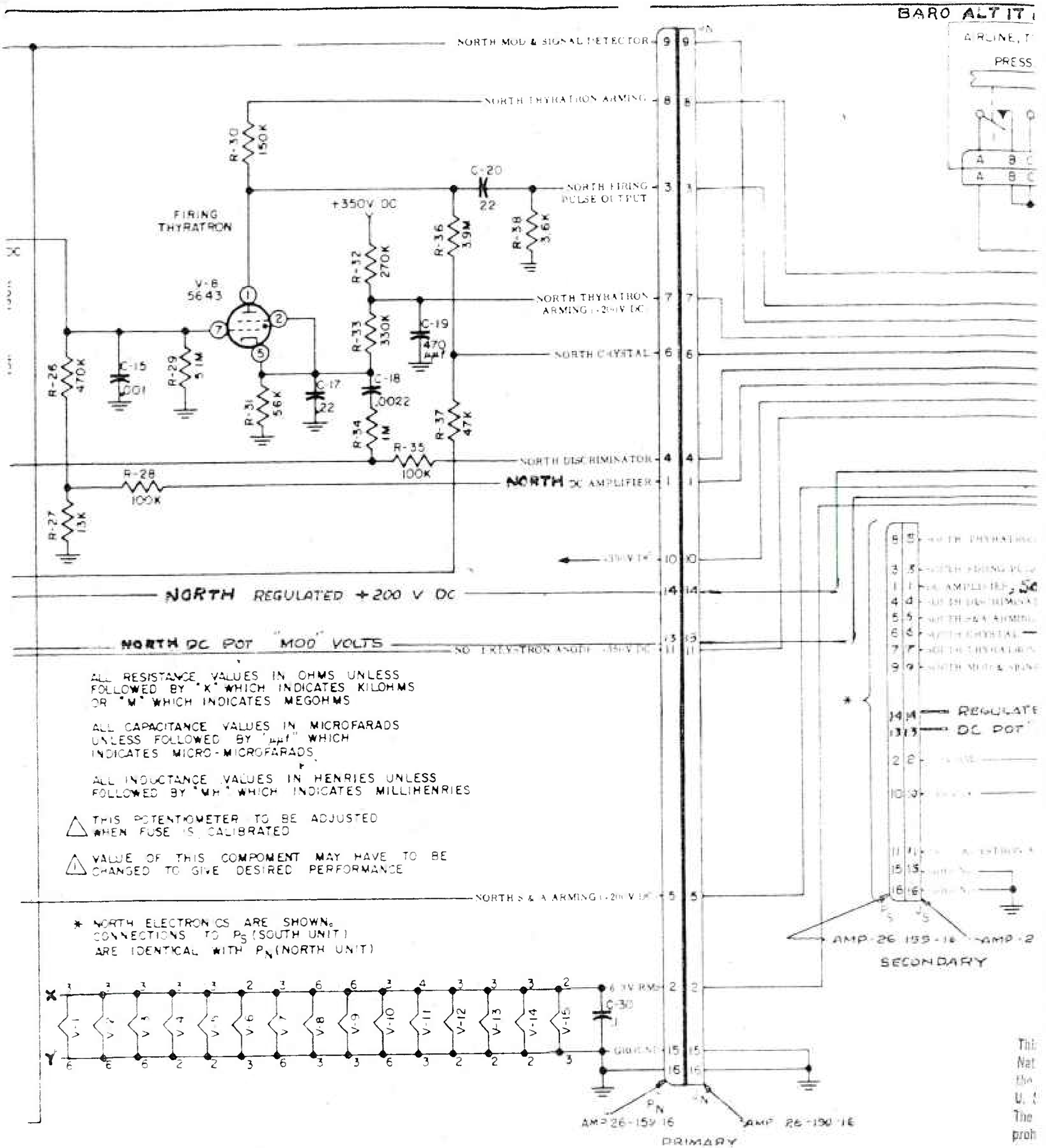

V-4
5647
SIGNAL
DETECTOR
(TELEMETRY)
R-14
470K
C-7
.047
+350V DC
DISCRIMINATOR
R-10
470K
C-5
470μμf
V-6
5647
R-17
240K
1W
T-2
+350V DC
R-11
6.8K
1W
R-12
6.8K
1W
R-13
18K
700T
750T
500T
C-8
20μμf
C-9
15μμf
R-15
120K
R-16
100K
C-10
.0022
C-12
.015
C-11
.0022
R-40
1K
DC
AMPLIFIER
R-20
510
+350V DC
R-22
560K
+350V DC
R-24
130K
R-25
15K
V-3
5840
L-2
11MH
R-9
220
C-3
.047
C-4
.047
C-6
.047
C-50
.0033
V-5
5647
C-52
.01
R-4C
1M
C-13
1
R-21
390K
V-7
5840
R-23
1K
R-26
470K
R-18
510K
R-19
75K
C-14
.001
R-27
13K
R-40
47K
C-22
1
L-3
400MH
T-4
C-28
.047
R-46
3.9M
C-25
500μμf
L-4
150MH
V-10
5840
R-45
39K
C-26
750μμf
R-67
13.6K
2W
C-27
1
+350V DC
R-48
150K
V-14
5647
R-44
120
+350V DC
R-56
10K
5W
SERVO AMPLIFIER
R-52
8.2K
T-5
C-39
910μμf
RF
SUPPLY
VOLTAGE
DOUBLER
R-47
220K
V-15
5647
V-13
5647
R-60
1.6M
R-57
1M
R-58
500K
C-40
.01
C-29
.22
R-61
3M
R-62
2K
C-35
.012
C-37
.01
V-11
5784WA
20KC
OSCILLATOR
R-59
100K
C-4
.022
R-53
100K
R-55
24K
V-12
5647
R-54
39K
C-38
.022
X
Y

(B)



ALL RESISTANCE VALUES IN OHMS UNLESS FOLLOWED BY "K" WHICH INDICATES KILOHMS OR "M" WHICH INDICATES MEGOHMS

ALL CAPACITANCE VALUES IN MICROFARADS UNLESS FOLLOWED BY "μμf" WHICH INDICATES MICRO-MICROFARADS

ALL INDUCTANCE VALUES IN HENRIES UNLESS FOLLOWED BY "MH" WHICH INDICATES MILLIHENRIES

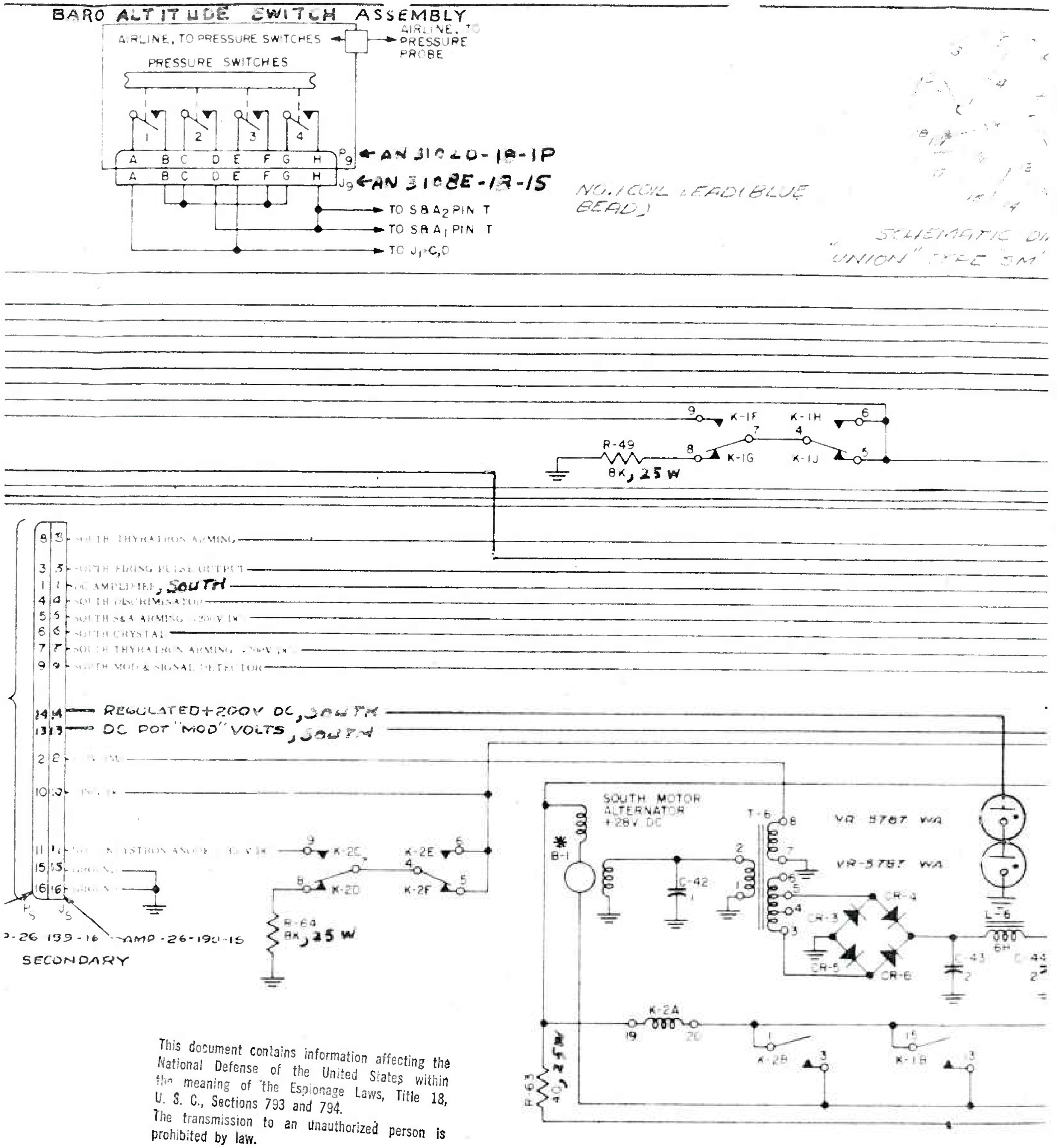
△ THIS POTENTIOMETER TO BE ADJUSTED WHEN FUSE IS CALIBRATED

△ VALUE OF THIS COMPONENT MAY HAVE TO BE CHANGED TO GIVE DESIRED PERFORMANCE

* NORTH ELECTRONICS ARE SHOWN. CONNECTIONS TO P_S (SOUTH UNIT) ARE IDENTICAL WITH P_N (NORTH UNIT)

C

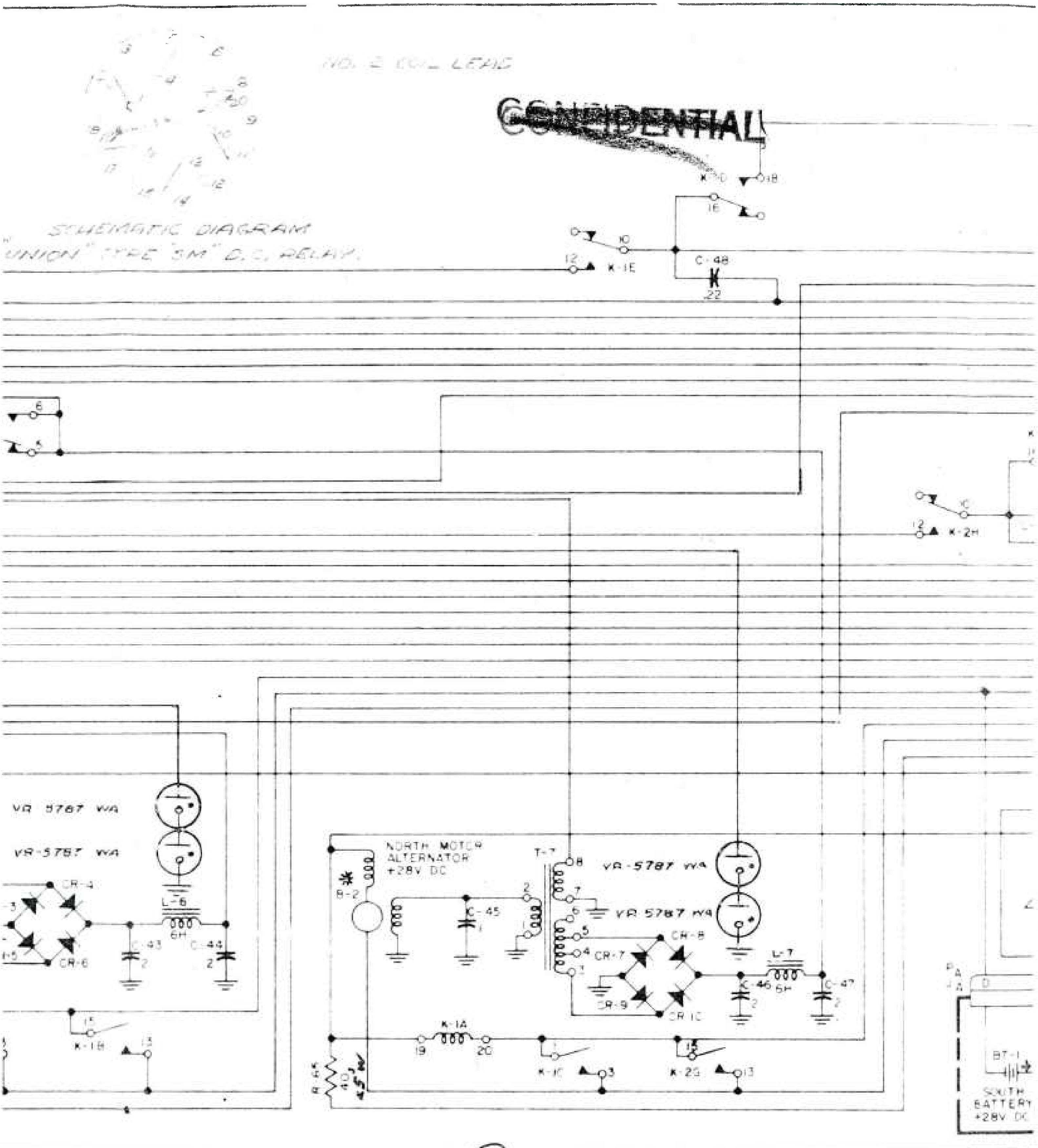
[redacted] C1



This document contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U. S. C., Sections 793 and 794. The transmission to an unauthorized person is prohibited by law.

D

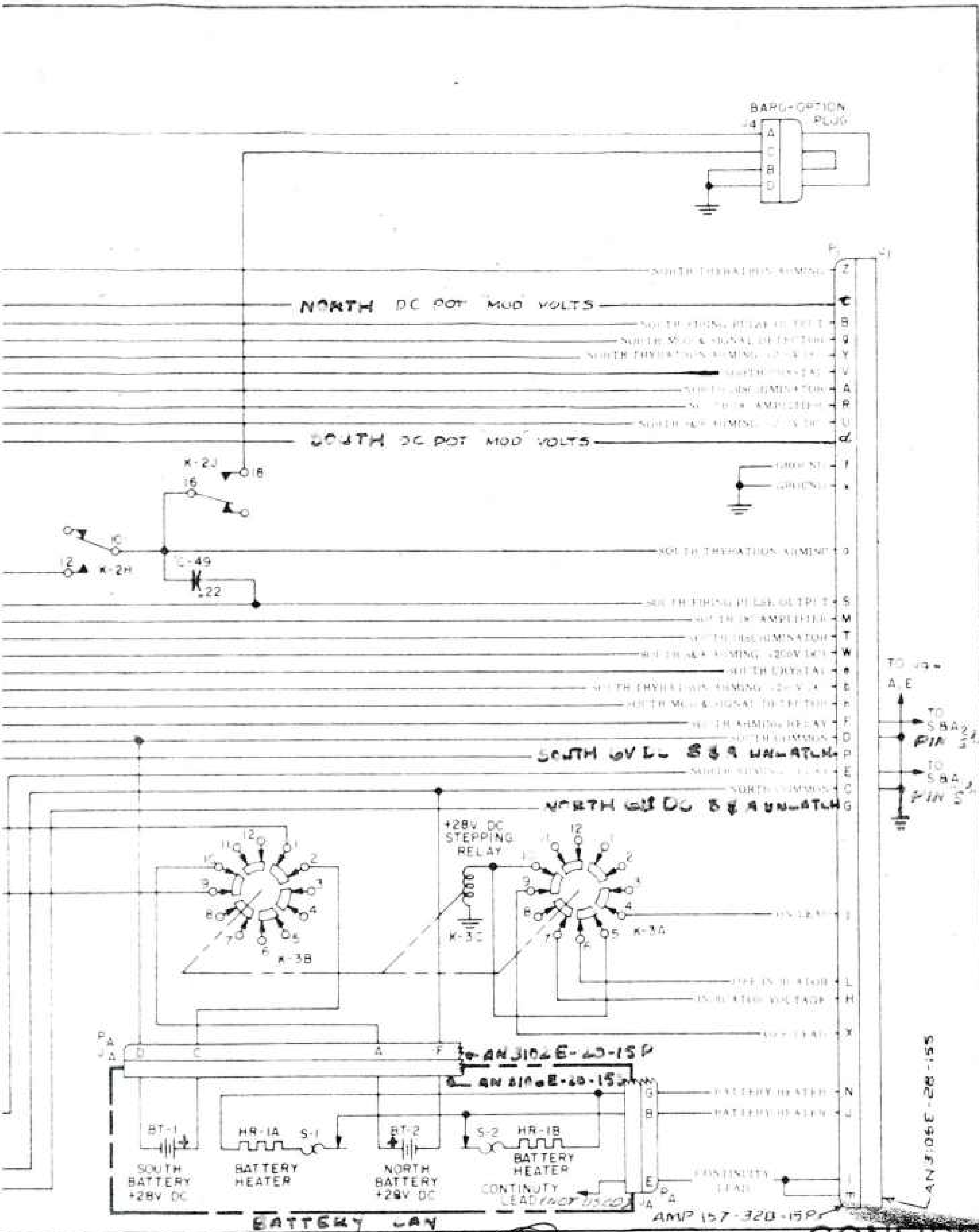
* NOTE.
THE ROTARY INVERTER HAS BEEN M
VOLTAGE REGULATOR SWITCH & R
WITH A FIXED RESISTOR OF A VA



E

-ER HAS BEEN MODIFIED BY REMOVING THE ROTATING
OR SWITCH & REPLACING THE SPARKING CAPACITOR
SISTOR OF A VALUE OF 150 OHMS & 10 W

Figure 34. T3008E5



e 34. T3008E5 Fuze Schematic

CONFIDENTIAL

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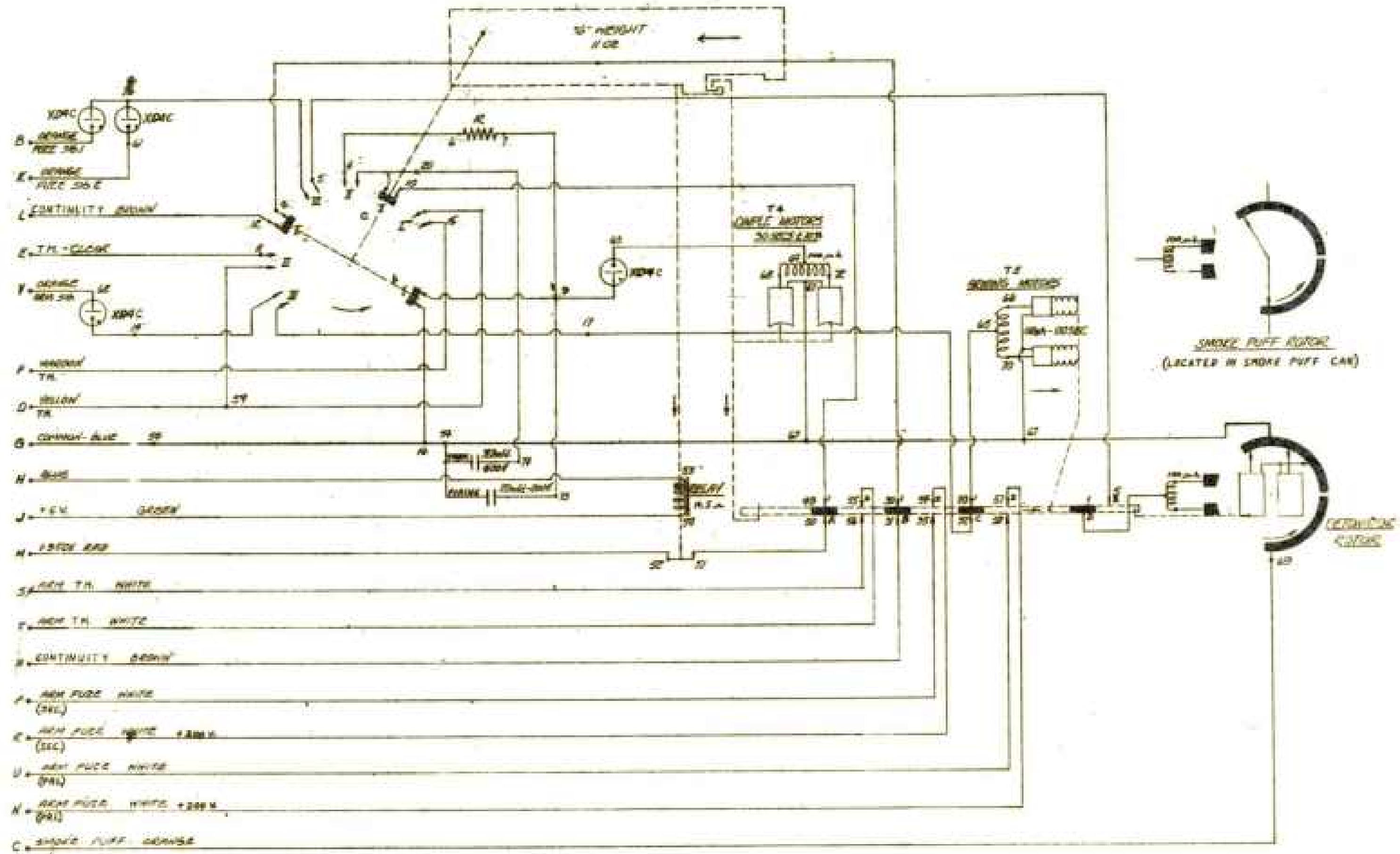


CANNON
GS02-22-14P-001

Figure 35. T3008E5 safety and arming device, (schematic diagram).

5.2.1.3.1 Transmitting Antennas

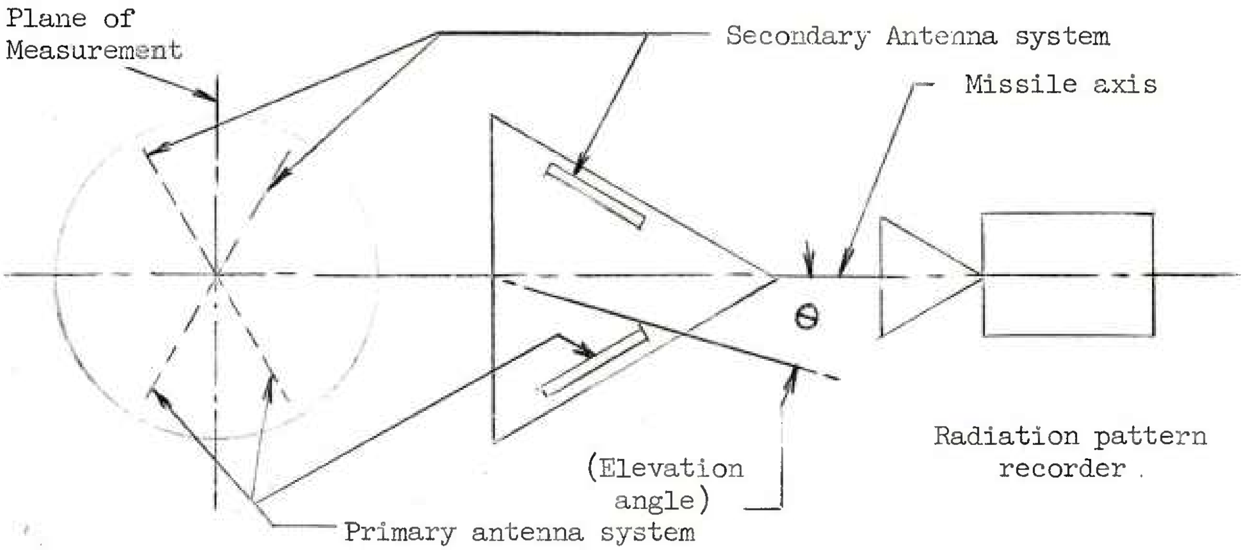
The transmitting antennas shall have a VSWR of less than 1.2:1.

5.2.1.3.2 Receiving Antennas

The receiving antennas shall have a VSWR of less than 1.6:1.

5.2.1.4 Antenna Gain Measurements

The gain of the antennas shall be measured in the plane defined by the axis of the cone and a line half way between the transmitting and receiving elements of each antenna system of the fuze (see diagram below).



5.2.1.5 Decoupling Between Antennas

The r-f decoupling between the transmitting and receiving elements of each antenna system shall be at least 50 db.

5.2.2 Microwave Balanced Mixer

The ratio of power in the receiving arm of the balanced mixer to the power out of the transmitting arm shall be held to -38 db or less. The local oscillator coupling to the mixer shall be -23 ± 2 db. The R-1 klystron input VSWR shall be less than 1.2:1. Each crystal current should be approximately 0.3 milliampere when the input power is 100 milliwatts.

5.2.3 Receiver-Amplifier

The receiver-amplifier consists of an input transformer and a three-stage, synchronously tuned amplifier. The band pass characteristics shall lie within the limit curves given in Figure 36.

5.2.4 Receiver-Amplifier and Discriminator

The over-all receiver-amplifier and discriminator band pass and gain characteristics shall lie between the limit curves given in Figure 37. The a-c/d-c voltage gain (receiver-amplifier gain control set to maximum gain) shall be measured as shown in Figure 38.

5.2.5 D-C Amplifier

The d-c amplifier voltage characteristic shall lie between the limit curves shown in Figure 39.

5.2.6 Thyratron

The cathode bias shall be + 30 ± 3 volts. The firing pulse generated by the thyratron shall have a minimum amplitude of 140 volts.

5.2.7 Oscillator

The oscillator shall be tuned to a frequency, $f_{osc} = f_s \pm 0.5$ kc/sec where f_s is the center frequency (20 ± 1.0 kc/sec) of the servo amplifier. The oscillator shall not vary in frequency more than ± 500 cycles/sec during warm-up from room temperature (70 F). The maximum oscillator modulation voltage available at the R-1 klystron repeller shall be 14 ± 2 volts rms. The total distortion of the oscillator shall be less than 10 percent.

5.2.8 R-F Supply

The output voltage of the r-f supply shall be adjustable from -240 ± 10 to -340 ± 10 volts. The output impedance shall not exceed 50,000 ohms for a load current of 1 milliampere or less.

5.2.9 Servo Amplifier

The center frequency f_s of the servo amplifier shall be 20 ± 1 kc/sec. The bandwidth of the servo amplifier shall be 5.0 ± 1.0 kc/sec at the 3-db points of the frequency-response curve. The open-loop voltage gain for the two stages of the servo amplifier shall be 40,000 ± 10,000.

5.2.10 Power Supply

The plate-supply voltage shall be adjusted to 350 ± 5 volts for a constant load of 90 ± 10 milliamperes. The ripple on the plate-supply voltage shall be less than one volt rms.

5.2.11 R-1 Klystron Frequency

The operating frequency of the R-1 klystron shall be f_o ± 200 mc/sec. A pair of R-1 klystrons used in the same fuze shall differ in frequency by at least 50 mc/sec.

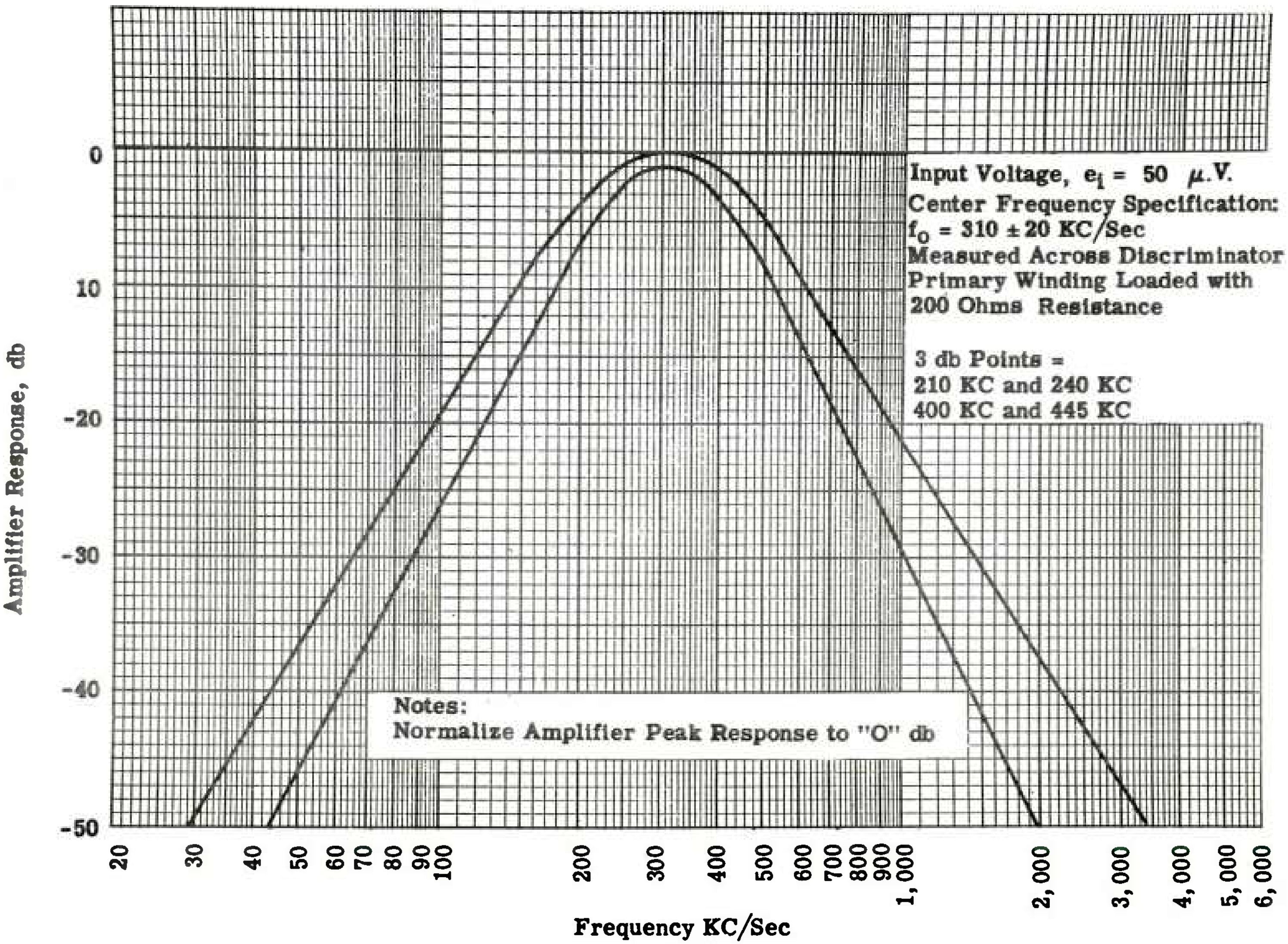


Figure 36. Receiver-amplifier characteristic.

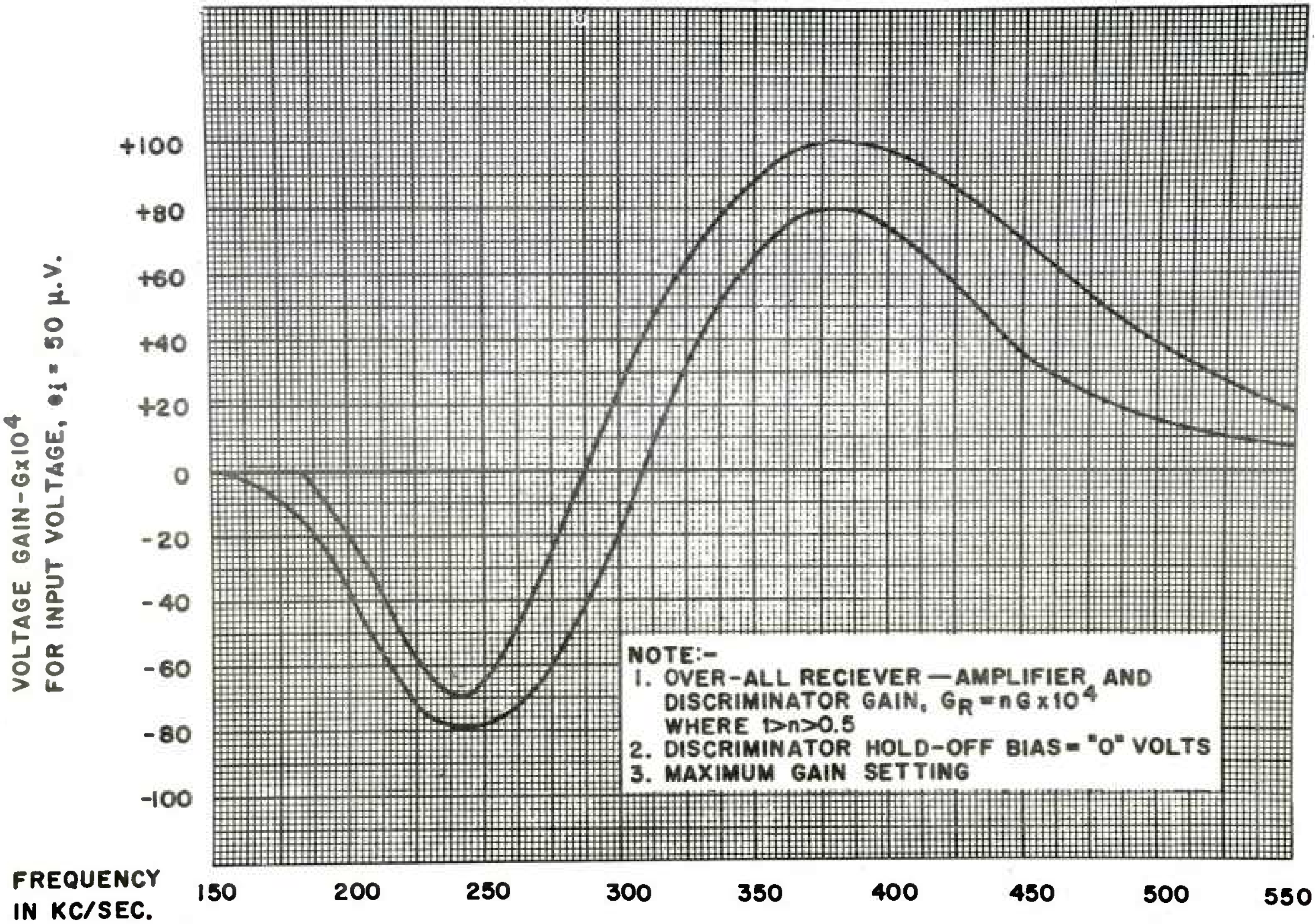


Figure 37. Over-all receiver-amplifier discriminator characteristic.

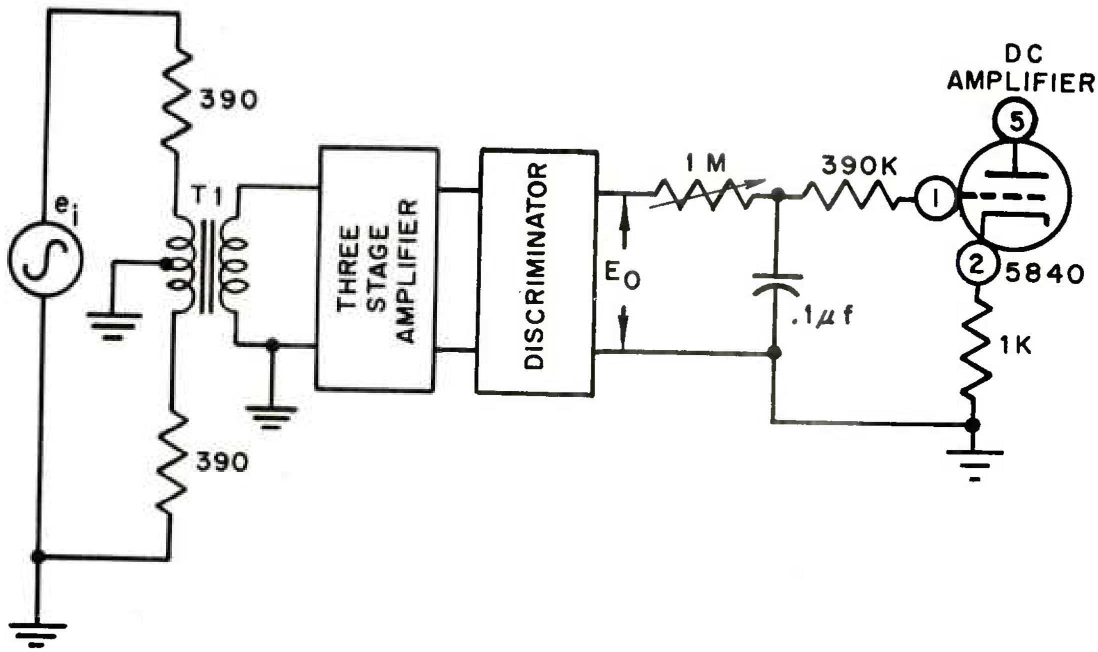


Figure 38. Method of measuring receiver-amplifier and discriminator gain bandpass.

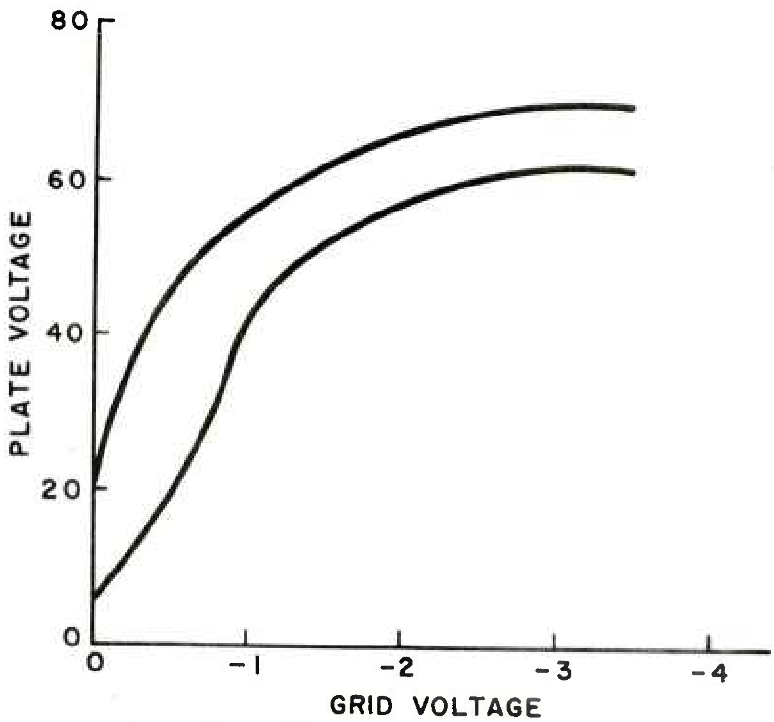


Figure 39. D-C amplifier response limits.

5.3 Requirements for S and A Device

5.3.1 Physical Requirements

5.3.1.1 The S and A device shall screw into the modified T-41 adapter which will be located in the warhead fuze well.

5.3.1.2 The S and A device may project up to 4 inches beyond the warhead, and the diameter of the projection can be as large as 4 inches if necessary.

5.3.1.3 The S and A device shall use two BS-30B detonators and two tetryl leads as shown on Ordnance Corps drawing No. P82350F.

5.3.2 Safety Features and Arming Sequence Requirements

5.3.2.1 At launching, the S and A device shall be capable of measuring 1.55 g absolute ± 10 percent for 30 seconds ± 10 percent.

5.3.2.2 The G-weight shall be locked in its rest position until it receives a 6-v d-c "intent-to-launch" signal from the T3008E5 fuze power supply.

5.3.2.3 The time measuring circuit shall operate from a 350-v ± 5-percent power supply which is part of the T3008E5 fuze launch panel. This voltage will be applied at intent-to-launch and precedes the 6-v d-c intent-to-launch signal by at least 10 milliseconds. Leakage resistance of the tank capacitor and timer capacitor must be at least 10,000 megohms.

5.3.2.4 If the G-weight is inadvertently unlocked, the 350-v dc will not reach the time measuring circuit and the arming sequence will be discontinued; thus rendering the device inactive.

5.3.2.5 If the S and A device is inadvertently armed, the 350-v dc will not reach the time measuring circuit; consequently, the mechanism will be rendered inactive.

5.3.2.6 Arming is to be completed when 200-v dc from the T3008E5 fuze power supply is applied to the S and A device at about 100 seconds after launching. This signal is initiated by command from the ground over the radar-Doppler link. Arming shall involve moving the out-of-line detonators into place and mechanically and electrically connecting the detonators to the fuze.

5.3.2.7 The fuze firing circuits and the arming circuit shall have isolation diodes.

5.3.2.8 There shall be three independent switches that close to complete the arming cycle.

5.3.2.9 If the T4 dimple motors, which normally operate at the end of the delay-time measurement period, are inadvertently fired before the S and A device receives an intent-to-launch signal or before it experiences 1.5 g gross acceleration, the arming sequence will not continue and the device will be rendered inactive.

5.3.2.10 If the T5 arming motors, which are normally operated after the arming signal has been given, are inadvertently fired before the S and A device has received an intent-to-launch signal or before the device has experienced 1.5 g gross acceleration, the unit will not arm and the device will be rendered inactive.

5.3.3 Safety Mechanical Requirements

5.3.3.1 The S and A device shall be in a safe condition after it has been subjected to the jolt tests specified in the Jolt Test Specification MIL-STD-350, 6 July 1951, and the drop tests specified in the Drop Test Specification MIL-STD-302, 6 July 1951.

The S and A device shall be capable of safe and reliable operation after it has been subjected to the transportation tests specified in the Transportation Test Specification MIL-STD-303, 6 July 1951.

5.3.4 Explosive Requirements

5.3.4.1 Warhead Detonator Safety

When the S and A device has been assembled into the warhead fuze well and the out-of-line assembly is in the safe position accidental explosion of the detonators, which are located in the S and A device, shall not cause the detonation or burning of the tetryl leads or the booster charge. In addition, ejection of parts or deformation or shattering of the barrier and the outer housing of the T-41 adapter shall not occur. These safe conditions shall be obtainable in an ambient temperature range from -65 F to +165 F.

5.3.5 Handling Safety

The design of the S and A device shall be such that the unit is not a hazard to the personnel handling it, even if an accidental explosion of the detonators should occur. Such an explosion shall be confined within the outer housing of the unit and shall not cause ejection of any component parts, detonation or burning of the tetryl leads, or deformation of the outer housing.

5.4 Environmental Conditions

5.4.1 The fuze shall operate properly ~~when subjected~~ to the environmental conditions specified below.

5.4.1.1 Temperature

-65 F to + 165 F.

5.4.1.2 Humidity

Zero to 95 percent relative humidity.

5.4.1.3 Altitude

Sea Level to 150,000 feet.

5.4.1.4 Vibration (type test)

Vibrations from 20 to 500 cycles/sec at 6 ± 2 g in each of three mutually perpendicular planes for a period of 3 minutes in each plane. This test is periodically performed to assure design adequacy. Units exposed to this test are not flight-tested in the missile.

5.4.1.5 Vibration (factory inspection test)

Vibrations from 20 to 500 cycles/sec at 5 ± 1 g for a period of 3 minutes along the axis of the nose-cone assembly. All nose-cone assemblies must operate properly during this test before they are delivered from the factory.

5.4.2 Storage and Transportation

5.4.2.1 The fuze shall not be damaged nor shall its performance be degraded when it is operated under conditions specified in 5.4.1 above, after being exposed for a long (5-year) period of time to the following nonoperating ambient conditions:

5.4.2.2 Temperature

-80 F to +165 F.

5.4.2.3 Humidity

Zero to 95 percent relative humidity.

5.4.2.4 Altitude

Zero to 30,000 feet.

5.4.2.5 Vibration

10-55 cycles/sec at an amplitude of ± .03 inch. 2

5.5 Pressurization

The nose-cone assembly shall be sealed at standard atmospheric pressure.

5.5.1 Leakage Rate

The internal pressure of the nose-cone assembly shall not drop more than 2 psi in 10 minutes after the pressure inside the nose-cone assembly has been increased to 15 psi above ambient pressure.

5.6 Applicable Military Specifications

The following military specifications are applicable to the T3008E5 fuze:

5.6.1 Resistors

MIL-R-11 Resistors, Composition
JAN-R-26 Power Resistor
JAN-R-94 Potentiometers

5.6.2 Capacitors

MIL-C-25A Metallized Paper
MIL-C-25 Metallized Paper (oil filled)
MIL-C-5 Ceramic

5.6.3 Subminiature Tubes

Electron Tube Approved List for U.S. Navy Guided Missiles:
- Diode 5647
- Triode (single) 5718
- Pentode 5840, 5784WA
- Thyratron 5643

5.6.4 Connectors

"AN" Connectors MIL-C-5015B (ASG)

5.7 Barometric Assembly Specifications

5.7.1 Operating Range

3,500 to 30,000 feet above mean sea level.

5.7.2 Electrical contacts

The electrical contacts shall be capable of carrying test current of 0.20 amp at 28-v dc.

5.7.3 Electrical Leakage

The dielectric resistance shall exceed 25 megohms between each element contact circuit pin and the common ground.

Leakage current across the contacts of each element shall not exceed 20 microamps when 150-v ac is impressed across the contacts and the sensing system of the assembly is subjected to an absolute pressure of 10 millibars.

5.7.4 Temperature Range

The barometric assembly shall be capable of operating over a temperature range of -65 F to +165 F.

5.7.5 Vibration

The barometric assembly shall operate satisfactorily when subjected to vibration accelerations not exceeding 10 g and with frequencies not exceeding 500 cps. The switch contacts shall not chatter on any sensing element with the switch held at an absolute pressure of 10 millibars above or below the actual operating altitude for any altitude setting within the setting range, a temperature of 75 F to 86 F, and vibration acceleration as specified in the preceding sentence.

5.7.6 Altitude Error

The altitude error should not exceed ± 1 percent over the range of 3,500 to 12,000 feet and ± 2.5 percent of the preset altitude from 12,000 to 30,000 feet.

5.7.7 Diaphragm Design

The diaphragm shall be designed to withstand exposure to pressure greater than atmospheric (not to exceed 22 psi absolute) and to pressure equivalent to extremely high altitude (1 mm Hg).

6. PERFORMANCE EVALUATION

6.1 Objective of Evaluation Program

The objective of the T3008E5 evaluation program was to determine whether the design of the fuze conforms to the military characteristics defined in the OCM and certain other characteristics imposed by field handling and the missile environment. The evaluation was based on the results of laboratory environmental tests, aircraft flight tests, and Corporal missile flight tests. Reports listed in the bibliography give information on the instrumentation and test procedures and additional detailed results.

6.2 Laboratory Tests

6.2.1 Nose-Cone Assembly Components

The components incorporated in the T3008E5 nose-cone assembly were chosen wherever possible on the basis of JAN military specifications. The major components include: inverters, capacitors, selenium rectifiers, potentiometers, resistors, power transformers, filter chokes, subminiature vacuum tubes, the R-1 klystron, cable connectors, and wiring. These components were selected to meet the temperature requirement of -65 F to +165 F and the vibration requirement of 15-g acceleration over the frequency range of 50 to 500 cps.

6.2.2 Nose-Cone Assembly Environmental Tests

6.2.2.1 Temperature Tests

A laboratory test was conducted to determine the effect of missile skin temperature on the operation of the T3008E3 nose-cone assembly which is basically similar to the T3008E5. (Measurements previously made by the missile contractor indicated that the inner surface of the Corporal missile nose cone reaches a maximum temperature of 375 F during flight, as shown in Figure 40.) In the laboratory test, a nose-cone assembly, with electrical power applied, was immersed in a vat of oil preheated to 450 F. The temperatures at several points within the nose cone were monitored. Although the skin temperature of the nose cone was maintained at approximately 430 F for over 5 minutes, its performance was not adversely affected. Figure 41 is a plot showing the temperatures at various times during the test. A more detailed description of the test is given in Progress Report PR-53-2.

A T3008E2 fuze, whose electronics system is also basically similar to the T3008E5 fuze, was subjected to temperature tests while mated to a Corporal missile. The fuze operated satisfactorily when subjected to temperatures ranging from -65 F to +190 F for prolonged periods of time (greater than 24 hours).

6.2.2.2 Rain Tests

A T3008E2 fuze nose-cone assembly mated to a Corporal missile was subjected to simulated rain tests which were conducted in accordance with the "Environmental Test Plan" outlined in the Physical Science Laboratory Report ORD(P)-182-80.001, dated 11 November 1954. The fuze operated satisfactorily during all phases of the tests.

6.2.2.3 Vibration Tests

A vibration test of each T3008E5 nose-cone assembly was included as part of the factory acceptance test. The purpose of the vibration test was primarily to uncover faulty workmanship and defective components. In this test, each nose-cone assembly was vibrated axially for a

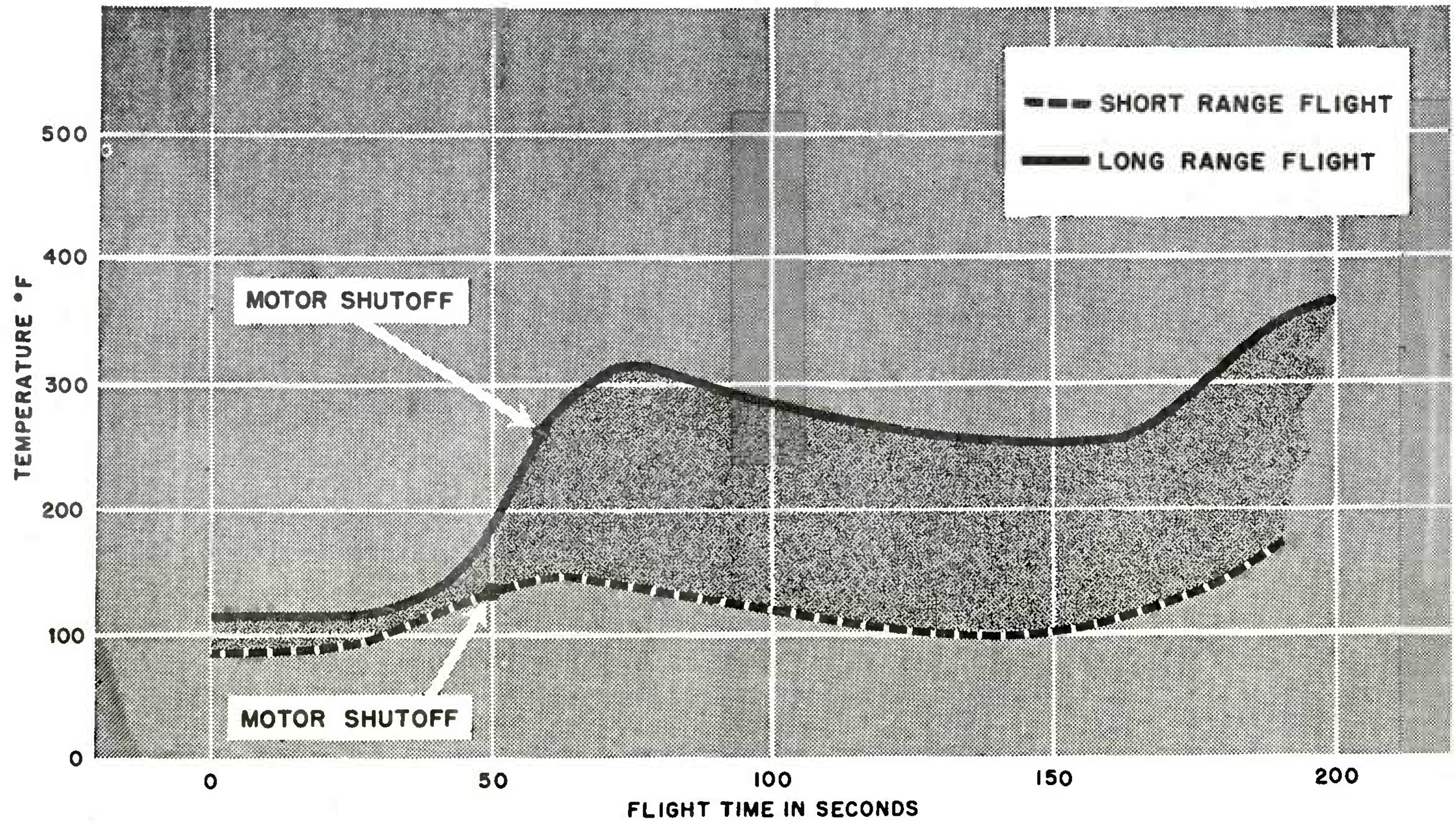


Figure 40. Temperature at inner surface of nose-cone assembly during missile flight.

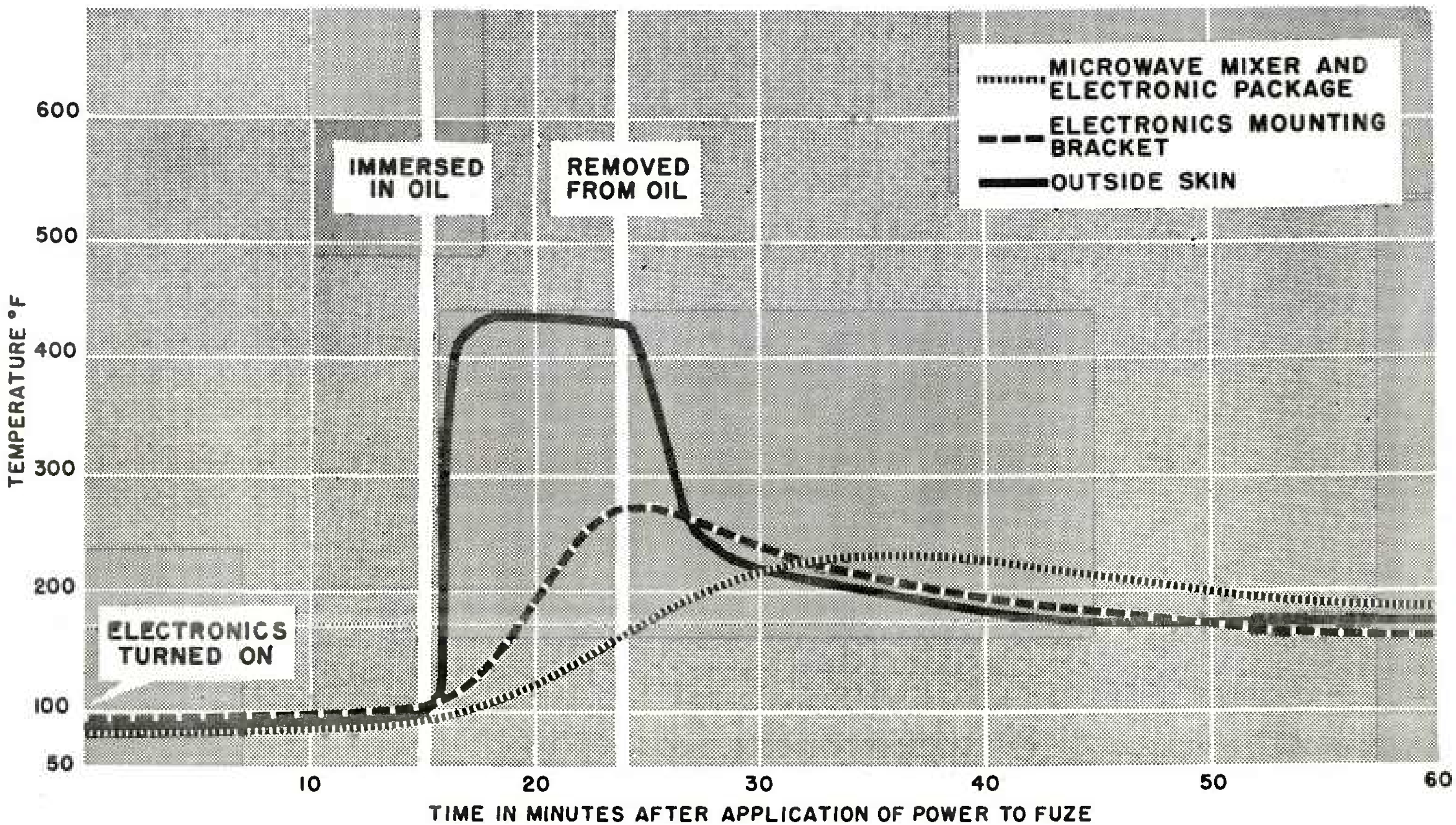


Figure 41. Temperature at various points in nose-cone assembly during oil-bath test.

period of at least 3 minutes over the frequency range of 50 to 500 cps at 5 g while the fuze was operated electrically. Assemblies that passed the vibration test were later flight tested aboard Corporal missiles.

One T3008E5 nose-cone assembly was vibrated for a period of 45 minutes at a vibration level of 5 g axially along the assembly. Operation was satisfactory during the test.

6.2.2.4 Pressure Tests

The Corporal missile reaches an altitude of over 100,000 feet. The nose-cone assembly is sealed at sea level pressure to prevent arcing of the fuze plate-supply voltage during flight. The pressure in the nose-cone assembly should not change more than 2 psi in 10 minutes when the assembly is subjected to a pressure differential of 15 ± 0.5 psi.

The complete T3008E5 nose-cone assembly has been pressurized by means of "O" rings and sealing compound. Laboratory test results indicate that the pressure in the nose cone does not change more than 1 psi in 10 minutes when the assembly is subjected to a pressure differential of 15 psi.

6.2.3 Safety and Arming

6.2.3.1 Handling Safety Tests

Picatinny Arsenal conducted the safety tests on the safety and arming device for the T3008E5 fuze. The following quotation was taken from a communication from that arsenal: "Group I Test has been completed on subject safety and arming mechanisms. Evaluated test results indicate that the T3008 safety and arming mechanisms are safe for flight in missiles having HE loaded warheads incorporated providing ground command to arm is not given until assurance is obtained that the missile has traveled a safe distance".*

6.2.3.2 Temperature Test of S and A Timer

The T3008E5 fuze safety and arming device for the Corporal missile operates on an electrical (RC) timing principle. Temperature tests made on a safety and arming timer gave the following results:

Temperature (°C)	Arming Time (Sec)

* For further details see Picatinny Arsenal final report on contract DAI-30-115-501-ORD(P)-405, dated 1 October 1954, Assignment III, "Testing and Evaluation of the Safety and Arming Mechanism for the Corporal T3008 Fuze".

Temperature (°F)	Arming Time (Sec)
+160	33.5
+150	42.2
+135	42.4
-35	25.7
-50	25.8

Larger time variations from the 30-second ± 10 percent time tolerance were obtained at the higher temperatures than at the lower temperatures. This effect is due largely to the high humidity that existed at the higher temperatures. A desiccant is supplied with each safety and arming device to minimize humidity effects. A desiccant was not used for the above test. The time variation would be reduced when a desiccant is used. The time values obtained at the lower temperatures are only slightly outside the 30-second time tolerance. The arming times listed above, however, would be satisfactory for use with the Corporal missile. The safety and arming timer must complete the sequence in less than 48 seconds which is the minimum boost time for the Corporal missile.

6.2.4 Fuze Calibration

A specially designed variable-delay waveguide device was used for calibrating T3008E5 fuze nose-cone assemblies prior to their flight testing aboard Corporal missiles. This device consists of a 500-foot length of waveguide coiled in the form of a vertical helix. The fuze range is varied by means of a steel target that travels along the helical path inside the waveguide. The target is propelled by a magnet which is arranged to move on the outside of the helix. Results of the laboratory calibration have demonstrated that consistent functioning of the T3008E5 electronic assemblies is obtained at a given (e.g., 150-foot-simulated) altitude with a laboratory precision of 1 percent.

6.3 Fuze Flight Tests Aboard Aircraft

6.3.1 Objectives

The objectives of the aircraft flight tests were to determine the maximum functioning heights and the functional accuracies of the primary and secondary electronic assemblies of the T3008E5 fuze. In these tests, the fuze nose-cone assembly was mounted on the nose of the aircraft at an angle corresponding to that attained by the fuze on a missile approaching a surface target. The aircraft carrying the fuze was flown over various types of terrain, including forest, tilled soil, and water. In each of the runs the aircraft was flown at a constant altitude and the fuze modulation voltage was swept at a uniform rate to simulate, except for Doppler effect, the approach of the missile to the ground. Since the weakest signal return was obtained from forest land, measurements of the maximum functioning height were mainly made over that terrain.

6.3.1.1 Maximum Height Tests

The maximum operating heights over forest terrain were determined separately for the primary and secondary electronic assemblies (Figure 42). Test results indicate that over this terrain the primary assembly will function up to approximately 6,300 feet and the secondary assembly will function at heights up to approximately 3,300 feet. However, these values will be lower for flights on a Corporal missile because of the Doppler effect produced as a consequence of the velocity of the missile.

The fuze electronic sensitivity at the maximum functioning height should be at least 10 db greater than the minimum value required to function the firing circuit. The 10-db excess sensitivity is required to offset effects of temperature, circuit parameter changes with life, etc. Height vs computed excess sensitivity for the primary and secondary electronic assemblies over forest terrain is listed below:

Electronic Assembly	Height (feet)	Excess Sensitivity
Primary	3,500	+ 7 db
Primary	3,000	+10 db
Primary	1,500	+18 db
Secondary	1,500	+10 db

It follows from this data that the secondary electronic assembly sets an upper limit to the functioning height of the T3008E5 dual fuze (electronic assemblies) at approximately 1,500 feet. This must be regarded as the maximum height at which the dual electronic fuze can be expected to function reliably for two extreme conditions that may be encountered: (1) missile roll over a large enough angle to make the primary assembly ineffective and (2) the worst type of target terrain (forest land).

6.3.1.2 Function Height Accuracy Tests

Function height data over forest, tilled soil, and water were plotted as shown in Figure 43. The shaded area of the plot primarily represents fuze function height deviation due to terrain variations.

For the small sample of functioning heights shown, all indicated bursts occur within plus or minus 15 percent of the preset heights.

6.3.2 Cloud Tests

The T3008E3 fuze electronic assembly, which is basically similar to the T3008E5 assembly, has been tested aboard aircraft to determine the effects of signal return from clouds.

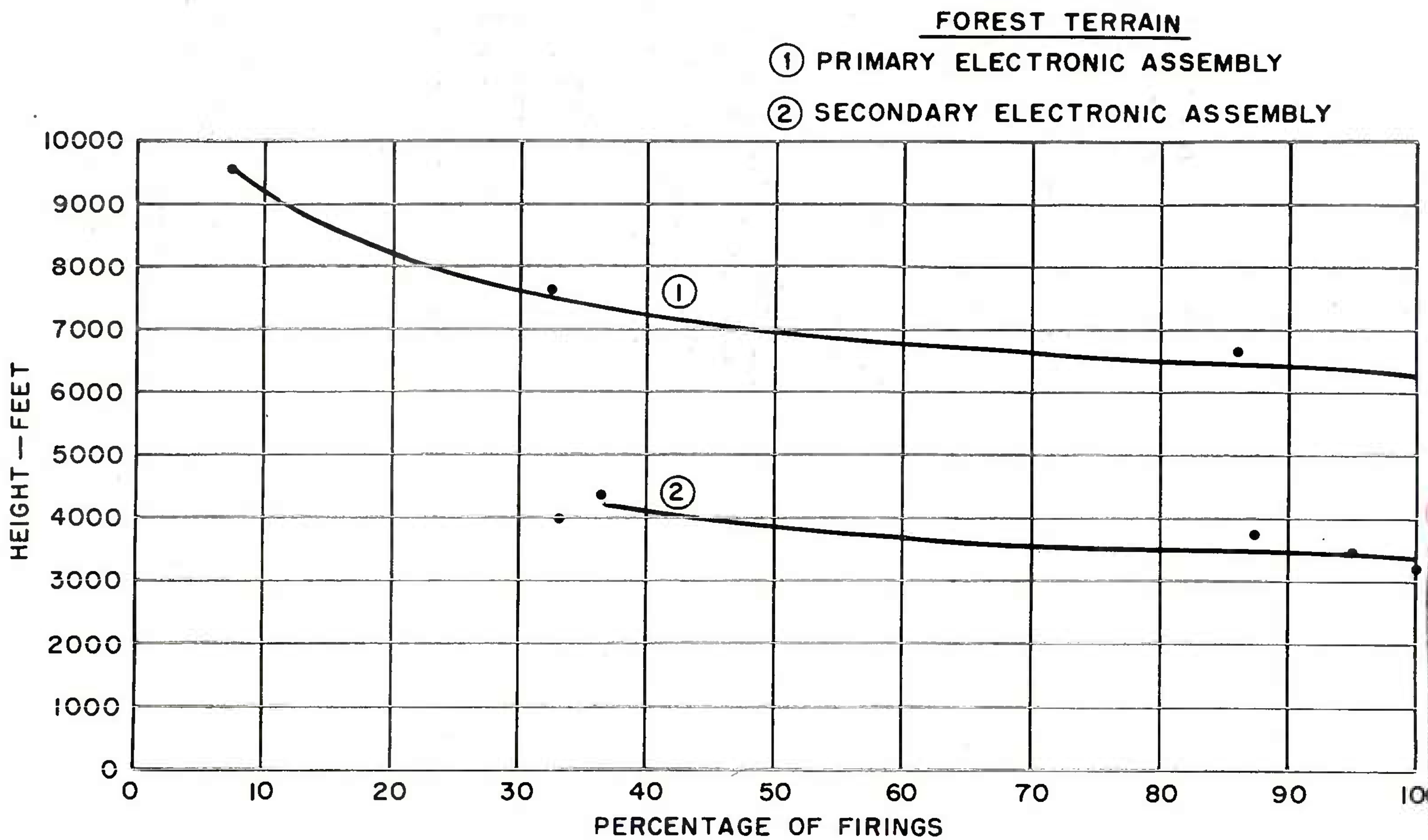


Figure 42. T3008E5 electronics function-height data.

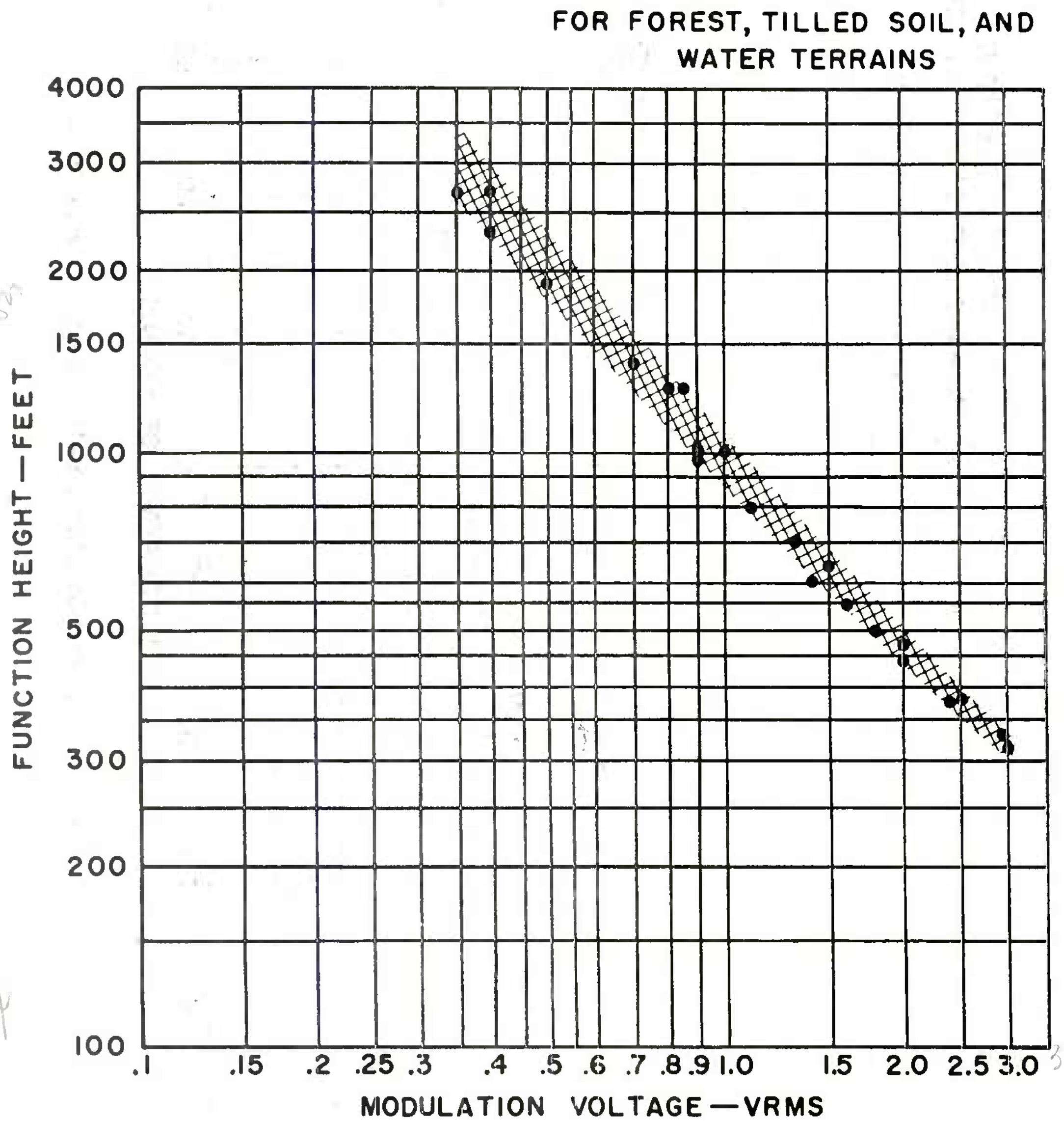


Figure 43. T3008E5 electronics system accuracy data.

No measurable signal return was obtained in tests of a fuze against cloud formations including nimbo-stratus (rain) clouds.

6.4 Fuze Flight Tests Aboard Corporal Missiles

At the beginning of the program, laboratory "breadboard" models were fabricated to determine system feasibility. As the program progressed, five successive models of the fuze, T3008E0, E1, E2, E3, and E5 were designed and subjected to various tests including flight tests aboard Corporal missiles. The design characteristics of these engineering models are described in paragraph 3.8. The results of the flight tests are summarized in the following paragraphs and Tables 1 and 2.

6.4.1 Fuze T3008E0

The T3008E0 fuze nose-cone assembly contained a single FM-CW electronic unit. Three of these fuzes were flight tested. The results of these tests provided a basis for subsequent design modification.

6.4.2 Fuze T3008E1

The T3008E1 fuze nose-cone assembly contained dual electronic units. Two fuzes of this design were flight tested aboard Corporal missiles. The fuze design was found to be inadequate for the levels of missile vibration experienced. A considerable portion of the subsequent development effort was therefore directed toward improving the mechanical structure of the fuze nose-cone assembly.

6.4.3 Fuze T3008E2

The construction of the T3008E2 fuze nose-cone assembly proved to be superior to that of the T3008E1 fuze. The packaging was simpler and more resistant to missile vibration.

Twenty of the T3008E2 fuzes, consisting of dual electronic assemblies, were tested aboard Corporal missiles. Three of the flights were considered to be "no tests" of the fuze because of missile failures. The results of the other seventeen tests indicated a substantial improvement in the mechanical design of the fuze. Summaries of the T3008E2 flight tests are given in DOFL Progress Reports PR-54-98 and PR-54-109.

6.4.4 Flight Test for Determination of Environmental Conditions

In addition to the aforementioned flight tests, a nose cone with special instrumentation for telemetering temperatures and vibrations at several points within the cone was flight tested aboard a Corporal Missile to obtain data on environmental conditions within the nose cone.

A temperature rise of 149F, due to aerodynamic heating, occurred in an electronic assembly mounted at the inner surface of the nose-cone skin.

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TABLE 1. SUMMARY OF T3008E5 FLIGHT TEST RESULTS

Flight Test Date	Corporal Missile Number	Fuze Serial Number	Primary Electronic Assembly	Secondary Electronic Assembly	Primary S and A Assembly	Secondary S and A Assembly	Barometric Assembly
12/1/55	TA40	1**	No Test	No Test	No Test	No Test	No Test
12/2/55	TA41	3	Proper	Dud	Dud	Proper	Proper
12/13/55	TA42	2	Early	Proper	Proper	Proper	Proper
12/14/55	TA43	7*	Proper	Dud	Proper	Proper	Proper
1/19/56	AEU-16	9	Proper+	Proper+	Proper	Proper	Proper
2/14/56	TA48	14*	Proper+	Proper+	Proper	Proper	Proper
3/2/56	TA52	11	Proper	Late***	Proper	Proper	Proper
3/2/56	AEN-18	12	No Test	No Test	Dud	Dud	No Test
4/5/56	AEN-27	10	Late ***	Late ***	Proper	Proper	Proper

* Barometric assembly used as fuzing device.

** Defective fuze cable assembly.

*** Insufficient r-f signal return from ground.

\+ Rated as proper although accurate function-height data could not be determined because of erratic missile performance.

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TABLE 2. PRESET AND FUNCTION HEIGHTS FOR T3008E5 FUZE TESTS

Corporal Missile Number	Fuze Serial Number	PRESET HEIGHT (FEET) Primary Electronic Assembly	PRESET HEIGHT (FEET) Secondary Electronic Assembly	PRESET HEIGHT (FEET) Barometric Assembly*	FUNCTION HEIGHT (FEET)** Primary Electronic Assembly	FUNCTION HEIGHT (FEET)** Secondary Electronic Assembly	FUNCTION HEIGHT (FEET)** Barometric Assembly*
TA41	3	75	4,320	20,300	72	Dud	20,600
TA42	2	6,000	65	16,050	8,800	55	15,600
TA43	7	75	2,380	13,300	87	Dud	13,300
AEU-16	9	1,000	950	12,300	Accurate data not available due to erratic missiles		
TA48	14	1,500	1,425	8,800			
TA52	11	3,500	3,325	10,700	3,640	1,950	10,700
AEN-27	10	5,000	3,000	12,200	2,250	1,900	11,850

* Height above mean sea level

** Determined from telemetry and missile flight data.

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The outputs from the vibration pickups indicated that the maximum vibration acceleration within the cone was 5 g.

The temperature and vibration data agree with the values measured by the missile contractor. These results coupled with the results of laboratory tests indicate that the T3008E5 nose-cone assembly will not be adversely affected by the missile flight environment.

6.4.5 Fuze T3008E3

The T3008E3 fuze incorporated modifications to effect structural and electronic improvements indicated from the work on earlier models of the fuze.

Fifteen T3008E3 fuzes (each containing 2 electronic assemblies and 2 S and A devices) have been flight tested aboard Corporal missiles at the White Sands Proving Ground, New Mexico. The results of these tests are contained in DOFL report TR-207 "Fuze, Guided Missile, VT, T3008E3, Design and Performance". The flight-test procedure for the T3008E3 fuze was similar to that for the T3008E5 fuze described below.

6.4.6 Fuze T3008E5 Corporal Missile Tests

Nine T3008E5 fuzes (each containing 2 electronic assemblies, a barometric assembly, and 2 S and A assemblies) have been flight tested aboard Corporal missiles at the White Sands Proving Ground, New Mexico. In preparing the fuze for flight testing at the proving ground, the nose-cone assembly, after the batteries were charged, but prior to mating to the B section, was given a Go, No-Go test by DOFL field-test personnel. The barometric assembly functioning height was preset for the appropriate altitude above mean sea level. The fuze cabling, the safety and arming assemblies, and ballast or dummy warhead were installed in the B and C sections. The assembled A, B, and C sections were then transferred to the missile flight-test group for mating to the after section of the missile. The complete Corporal missile was then transported to the launching site for erection. In general, a missile was erected from two to ten days before launching. The batteries in the fuze remained charged for this period of time. The fuze was exposed to weather conditions that existed in the launching area. The battery heaters, which were controlled by a thermostat in the fuze battery pack, were used for approximately one hour before launch when cold temperatures prevailed. The nine T3008E5 fuze test results are as follows (see also Tables 1 and 2).

6.4.6.1 1 December 1955 Test (TA 40)

The first T3008E5 flight was evaluated no test because of a faulty cable assembly. This defect prevented unlatch of the G-weights in the S and A devices. The fuze system remained inoperative since fuze turn-on is dependent on the S and A unlatch function. Corrective measures were taken to insure proper cabling.

6.4.6.2 2 December 1955 Test (TA 41)

The primary electronic assembly and the barometric assembly functioned properly within allowable height limits. The secondary electronic assembly was a dud. Analysis indicated that the dud could have been caused by insufficient klystron servo error signal or by insufficient r-f signal return from the target area.

6.4.6.3 13 December 1955 Test (TA 42)

The secondary electronic assembly and the barometric assembly functioned properly within allowable height limits. Analysis of the telemetry records indicated that the primary unit klystron was off-mode center, causing an early function. The off-mode operation of the klystron was attributed to the generation of insufficient servo error signal at heights above approximately 2,000 feet. The speed-regulated inverter, which was employed to help prevent klystron drift, failed to regulate within specifications.

6.4.6.4 14 December 1955 (TA 43)

The primary electronic assembly and the barometric assembly functioned properly within allowable height limits. The secondary electronic assembly was a dud. Telemetry data indicated insufficient microwave power output from the klystron. Analysis indicated that the output voltage of the speed-regulated inverter varied, causing improper klystron operation.

The barometric assembly option was used for this test. Baro option was obtained by insertion of the option plug at the base of the A section.

6.4.6.5 19 January 1956 Test (AEU-16)

The primary and secondary electronic assemblies and the barometric assembly functioned properly. However, accurate function height data could not be obtained because the missile rolled and gyrated during flight.

6.4.6.6 14 February 1956 Test (TA 48)

The primary and secondary electronic assemblies and the barometric assembly functioned properly. Accurate function height data was not obtained because of erratic missile performance.

An interfering signal, which caused a nonfiring (positive) signal from the discriminator, was observed on the "rectified video" telemetry channel of the primary electronic assembly. It was determined that six X-band radar sets were in operation near the test site during this missile flight. Fuze operation was proper in the presence of the interfering radar signals.

The barometric assembly option was used for this test. Baro option was obtained by insertion of the option plug at the base of the A section.

6.4.6.7 <u>2 March 1956 Test (TA 52)</u>

The primary electronic assembly and the barometric assembly functioned properly within allowable height limits. However, the secondary electronic assembly functioned 40 percent below the preset height. The cause of the late function was low r-f signal return to the secondary electronic assembly.

(NOTE: The erratic action of the speed-regulated inverter in the fuze power supply made it necessary to eliminate the regulator from the inverter. Voltage regulator tubes were substituted to control the fuze voltages. Laboratory tests indicated satisfactory operation of the modified fuze. The T3008E5 fuze used for this test was the first modified unit. The two fuzes that were subsequently flight tested as described below were also modified in this manner.)

6.4.6.8 <u>2 March 1956 Test (AEN-18)</u>

The missile was proper for this test. The safety and arming G-weight setback functions were also proper. However, the lockback function was absent from both S and A assemblies. As a result the fuze was not armed (even though command arm was present), and microwave radiation "turn-on" did not occur. This resulted in a no test of the fuze. The cause of the S and A failures is not known. Possible explanations are that both devices failed simultaneously or that there was a lack of S and A charging potential from the launch panel.

Both S and A assemblies and the launch cabling checked out properly prior to flight. The correct launch procedure was used. The occurrence of the two S and A duds was the first failure of this type in 49 flight tests of the T3008 fuze.

6.4.6.9 <u>5 April 1956 Test (AEN-27)</u>

The barometric assembly functioned properly within allowable height limits. The primary and secondary electronic assemblies functioned late, below the preset heights. The cause of the late function was low r-f signal return at the higher heights (above 1,500 feet).

6.4.6.10 <u>Flight Test Summary</u>

Based on the results of a limited number of missile and aircraft flight tests the following conclusions are drawn:

a. Satisfactory fuze operation at low heights (approximately 75 feet).

b. Satisfactory fuze operation at heights of 1,500 feet and below. The 1,500-foot upper height limit is imposed by the secondary electronic assembly. One missile flight test (TA 52) indicated satisfactory operation of the primary electronic assembly at a height of 3,500 feet.

c. Satisfactory operation of the barometric assembly. Tests were obtained at the following approximate altitudes above mean sea level: 20,000 ft, 16,000 ft, 13,000 ft, 12,000 ft, and 11,000 ft. All of these function heights were within allowable limits. The baro option circuit was used in two of the tests.

7. CONCLUSIONS

7.1 The T3008E5 fuze conditionally conforms to the major military characteristics established by the Ordnance Committee Item 34280, and other missile and field handling environment characteristics, except for the S and A device which is limited to operation in the temperature range of -25F to +130F.

7.2 The operating height of the T3008E5 fuze is limited to the ranges of 75 feet to 1,500 feet and 3,500 feet to 20,000 feet above the impact terrain.

8. RECOMMENDATIONS

8.1 It is recommended that the T3008E5 fuze be subjected to:

(1) Additional flight tests aboard the Corporal missile for more complete performance evaluation over the entire range of function heights.

(2) Additional laboratory tests over the temperature range of -65F to +165F.

8.2 It is recommended that any additional units which are produced incorporate the following component improvements:

(1) Thermal batteries instead of wet-cell batteries.

(2) Explosive motors in the safety and arming device which are capable of performing over an ambient temperature range of -65F to +165F.

(3) R-1B Klystron in place of R-1A

8.3 It is recommended that the T3008E5 fuze launch equipment, for use with the Corporal missile, be modified for the Warhead Remote Monitor* at the missile firing panel.

* Letter to Jet Propulsion Laboratories from Sandia Corporation, dated 25 January 1956, ref sym 1220(4), R and D File No. Z7.3-2.1.

9. <u>SUMMARY OF SIGNIFICANT HISTORICAL EVENTS</u>

OCM Item 33600	15 Jan 1951	Fuze, Guided Missile, VT, T3008; specific design study for Corporal and Hermes Guided Missiles.
Research and Development Contract CST-391	1 Feb 1951	T3008 fuze design and feasibility study.
Safety and Arming Device	10 Jan 1952	Research and development of T3008 Safety and Arming Device initiated.
Safety and Arming Flight Test	15 Mar 1952	First T3008 flight test of S and A on Corporal missile.
Missile Flight Test	17 Mar 1952	First Corporal flight test of T3008E0 single electronic fuze.
DOFL Internal Research and Development	15 April 1952	DOFL internal effort initiated for fabrication of 26 T3008E2 dual electronic fuzes.
OCM Item 34280	5 June 1952	VT Fuzes for the Corporal (XSSM-A-17) Guided Missile; initiation of development project for Fuze, Guided Missile, VT, T3008 for the Corporal (fragmentation-type warhead) Guided Missile.
Missile Flight Test	3 Dec 1952	First Corporal flight test of T3008E1 dual electronic fuze.
Missile Flight Test	5 Feb 1953	First Corporal flight test of T3008E2 dual electronic fuze.
Research and Development Contract DAI-49-186-502-ORD(P)-33	18 May 1953	Contractor research and development effort initiated for 15 T3008E3 dual electronic fuzes. Aircraft flight tests of fuze systems initiated.
Fuze Prototype Construction	15 Aug 1953	Prototype T3008E3 fuze completed. Laboratory evaluation tests (electrical, vibrational, temperature, etc.) of prototype initiated.

Research and Development Contract DAI-49-186-502-ORD(P)-149	8 Jan 1954	Contractor research and development effort initiated on 15 T3008E3 dual electronic fuzes.
Safety Tests	26 Jan 1954	T3008 safety tests completed by Picatinny Arsenal.
ORDTA Ltr to DOFL, file 00/4S-4771	21 June 1954	Initiated development of "Extended Range" (T3008E5) fuze.
Research and Development Contract DAI-49-186-502-ORD(P)-241	30 June 1954	Contractor research and development effort initiated on 15 T3008E5 dual electronic fuzes with barometric option.
DOFL Ltr to ORDTA	13 Aug 1954	Describes T3008E5 fuze.
Missile Flight Test	23 Sept 1954	First Corporal flight test of T3008E3 dual electronic fuze.
Environmental Test	Nov-Dec 1954	Environmental temperature, humidity, and rain tests of T3008E2 dual electronic fuze mated to Corporal missile at WSPG, N. M.
Missile Flight Tests	23 Sept 1954 - 19 Aug 1955	Fifteen T3008E3 dual electronic fuzes flight tested aboard Corporal missiles during this period.
DOFL Ltr to ORDTA	24 June 1955	Defined design objectives for T3008E5 fuze.
Fuze Fabrication	Oct 1955	First T3008E5 fuze fabrication completed.
Fuze Fabrication	30 Nov 1955	Fabrication of 30 T3008E3 dual electronic fuzes completed.
Design and Performance Report	30 Jan 1956	Issuance of Report "Fuze, Guided Missile, VT, T3008E3, Design and Performance".
Fuze Fabrication	31 Mar 1956	Fabrication of 15 T3008E5 dual electronic fuzes, with barometric devices, completed.
Missile Flight Tests	1 Dec 1955 - 5 Apr 1956	Nine T3008E5 dual electronic fuzes, with barometric devices, flight tested aboard Corporal missiles during this period.

10. BIBLIOGRAPHY

1. "Nonquantized FM Altimeters" - Kalmus, Henry P., Cacheris, J. C., Dropkin, H. A., (U) Report No. 17-121, 2/12/53.

2. "Numerical Data on the Probability of Proper Function of Multiple Fuzing Systems" - Kohler, H. W. (C), Report No. TR-34, 1/27/54.

3. "An Analysis of Simple Multiple Fuzing Systems" - Domsitz, M., (U), 13.0-76M, 10/7/52.

4. "Economics of Fuzing" - Goldberg, H., (S), Report No. 17-48, 7/2/52.

5. "An Analysis of FM-CW Detection Systems" - Goldberg, H., (S), No. 13.4-4R, 11/19/48.

6. "Type IN23 Crystal Diode Tests" - Pidcock, Pvt. J. S., (S) No. 13.4-165R, 9/11/51.

7. "Return Signal Strength Contours Projected on the Earth's Surface by the Antenna Systems of Fuze T3008" - Morrison, R. F. (C), Report No. TR-107, 7/15/51.

8. "An Averaging Device for FM Altimeter Systems with a Special Application to the Delta Fuze" - Hardin, C. D. and Friedberg, I. S., (S), Report No. 17-131, 3/18/53.

9. "Angle Modulation Fuze with Small Deviation" - Kalmus, H. P., (S) Report No. 13.4-112R, 11/7/50.

10. "Preliminary Development, Testing and Status of the S and A mechanism for Corporal (T3008) Fuze" - Danner, B., (C), Report No. 17-276, 9/25/53.

11. "Temperature Effects on the Type of Wiring Used at NBS in the T3008 Fuze" - Block, M. (C), Report No. 17-109, 11/24/52.

12. "Some Considerations Involved in the Specification of VSWR Presented to the Klystron" - Pepper, W., (S), Report No. TR-121, 4/10/55.

13. "Measurement of Deviation Sensitivity of Klystrons" - Hedrich, A. and Kaufman, B. (S) Report 13.4-174R, 10/11/51.

14. "Measurement of Klystron FM Noise" - Kalmus, H., Hedrich, A., and Kaufman, B. (S), Report 13.4-172R, 10/11/51.

15. "Operational Characteristics of Several R-1 Klystrons" - Mitchell, F., (S), Report 13.4-138R, 8/10/50.

16.. "Development of the R-1 Klystron" - Holmboe, L., (S) Report 17-123, 2/9/53.

17. "Harmonic Analysis of the Amplitude Modulation on the Output of a Frequency Modulated Klystron" - Hedrich, A., (S) Report 13.4-115R, 12/9/50.

18. "Measurement of FM Distortion in the R-1A Klystron" - Witte, J.(S) Report TR-103, 7/21/54.

19. "A Study of R-1 Klystron Characteristics as they Affect Guided Missile Fuze Operation" - Sanders, M. and Sawyer, L. (S), 13.4-176R, 12/11/51.

20. "Repeller Transfer Characteristics of a R-1 Klystron" - Becker, S. and Silverstein, A., (S) Report 13.4-44R, 8/12/49.

21. "Specification Type R-1A Reflex Klystron" - Holmboe, L. (S) 12.2-359R, 3/26/53.

22. "Slotted Wave Guide Radiators, Part I" - Schwartz, R. (U) Report No. 13.4-37R, 8/16/49.

23. "Engineering Report on the T3008E3 Fuze" Report No. 585, The Emerson Electric Manufacturing Company under contract DAI-49-186-ORD(P)-33.

24. "Oscillator and RF Power Source" - TM 17.8401-2 - Darcey, R. J. Ordnance Electronics Division, NBS, 11/25/52.

25. "Klystron Repeller Power Supply" - TM 17.8401-4 - Darcey, R. J. Ordnance Electronics Division, NBS, 3/31/53.

26. "An Analysis of the Delta Series Amplifier" - Emerson Technical Memo, Fordyce, S., 2/3/54.

27. "Maintenance Instructions for Nose Cone Assembly of T3008E3 Fuze System", DOFL Report TR-E-196 (C).

28. "Design Study for Production T3008E3 Fuze" - Emerson Electric Manufacturing Company, Report No. 594.

29. "Warhead Design Information for Corporal XSSM-A-17 and XM2E1 No. 7-1"- Jet Propulsion Laboratory under Contract No. DA-04-495-ORD 18, Dept. of the Army, Ordnance Corps.

30. "Method of Calculating T3008E3 Fuze Functioning Height" - Taylor, R.E., TM 41.03-8, 5/15/55.

31. "Factors Affecting the Height Setting of T3008E3 Fuze" - Taylor, R.E., TM 41.00-5 5/15/55.

32. "Thirty Degree Corporal Antenna" - Morrison, R. F., TM 41.3-22, 1/22/54.

33. "Covers for Slotted Waveguide Antennas" - Morrison, R. F., Report No. TR-91, 5/25/54.

34. "Testing and Evaluation of the Safety and Arming Mechanism for the Corporal T3008 Fuze" - Picatinny Arsenal, Contract DAI-30-115-501-ORD(P)-405, Assignment III, Group I Tests (Safety), 10/1/54.

35. "Operating and Field Handling Proceedures for T3008E3 Fuze",- Report TR-E-105, 8/1/55 (C).

36. "Physical Science Laboratory Report" - ORD(P)-80.001, 11/11/54.

37. "Testing and Evaluation of the Safety and Arming Mechanism for the Corporal T3008 Fuze" - Picatinny Arsenal final report on contract DAI-30-115-501-ORD(P)-405, 10/1/54, (C).

38. "Final Report on Contracts ORD(P)-299 and ORD(P)-33 - Emerson Electric Manufacturing Company (S).

39. "The Fuze Servo as a Feedback Problem" - Gale, M. and Spalding, J. P. Report 13.4-119R, 1/9/51.

40. "Drop and Vibration Tests Conducted on Dummy Corporal Missile Nose Sections", Lord Manufacturing Co., Erie, Pa., Report No. 45.

41. "Fuze, Guided Missile, VT, T3008E3 Design and Performance" (S), Taylor, R. E. and Fohrman, E. F., Report No. TR-207, 30 Jan. 1956.

42. "T3008E3 Fuze Environmental Flight Test at WSPG" - Report No. TR-F-28, 12/13/54.

43. "R-1B Klystron Oscillator Development Program" - Varian Associates Final Report, Feb 1956 (C).

44. "Method of Calculating T3008E5 Fuze Functioning Height" - Taylor, R. E., TM 41.3-56-3 (C), 2/9/56.

45. "Countermeasures Susceptibility of the T3008 (Delta) Fuze" - Airborne Instruments Laboratory, Inc., Mineola, N. Y., Report No. 2016-16 (S), Dec. 1955.

46. "T3008E3 Fuze Summary Flight Test Report" - Taylor, R. E. and Monjar, V.- Report No. TR-F-34 (S)

47. "On the Possibility of Satisfying Conarc's Fuzing Requirements" - Mittleman, Don, Report TR-203 (S), 8/1/55.

48. "Contours of Constant Proper Function Probability for Multiple Fuze Systems" - Kohler, H. W., Report No. TR-126 (C), 11/21/54.

49. "A study of Operating Parameters for Supermicrophonic FM Fuze Systems, Salerno, J., Friedberg, I. S., and Hardin, C. D., Report No. TR-32 (S), 1/25/54.

50. "Guided-Missile Fuze Symposium held at DOFL 3 and 4 Nov 1954" 7/20/55 (S)

51. "Test Data T3008E5 Delta Fuze" for Nose-Cone Assembly Serial Nos. 1 - 15 inclusive (S), - The Emerson Electric Manufacturing Co.

52. "The Variability of Atmospheric Pressure - II", Sandia Corp Technical Memo 160-55-51, Charles, B. N., 5/19/55.

PROGRESS REPORTS

Number	Period	Date
2A-109	1 September 1951 through 30 November 1951	12 March 1952
2A-116	1 December 1951 through 30 April 1952	18 June 1952
2A-128	1 May 1952 through 31 July 1952	17 December 1952
2A-135	31 July 1952 through 31 October 1952	8 April 1953
2A-147	1 November 1952 through 31 January 1953	17 June 1953
2A-150	1 February 1953 through 30 April 1953	31 August 1953
2A-157	1 May 1953 through 31 July 1953	18 December 1953
PR-53-2	1 August 1953 through 31 October 1953	31 March 1954
PR-54-22	1 November 1953 through 31 January 1954	23 August 1954
PR-54-40	1 February 1954 through 31 May 1954	18 March 1955
PR-54-98	1 June 1954 through 31 August 1954	20 May 1955
PR-54-109	1 September 1954 through 30 November 1954	20 June 1955
PR-55-40	1 December 1954 through 31 August 1955	27 February 1956
PR-56-17	1 September 1955 through 30 November 1955	21 May 1956
PR-56-27	1 December 1955 through 29 February 1956	11 June 1956
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22 Hinman, W. S.
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24 Horton, B.M./Fitzgerald, R.T.
25 Taylor, R. E.
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